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TRANSACTIONS
Kansas Academy of Science.

VOL. XII.

1889-90.

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TRANSACTIONS

OF THE

TWENTY-SECOND MEETING

OF THE

KANSAS ACADEMY OF SCIENCE,

1889,

WITH THE REPORTS OF THE SECRETARY.

VOLUME XII.—PART I.

TOPEKA.
KANSAS PUBLISHING HOUSE: CLIFFORD C. BAKER.
1890.

TRANSACTIONS.

THE Kansas Academy of Science met in its twenty-second annual session at Wichita, on October 23d, 24th and 25th, 1889. From the minutes of the Secretary the following notes are made:

The report of the Treasurer, I. D. Graham, after being reported upon by the auditing committee, was accepted.

The committee appointed to consider the subject of immediate publication made the following report, which was adopted:

1. The authors of papers shall have the consent of the Academy to publish any papers, with due credit to the Academy, when and where they choose, after reading at the meeting.

2. The publication committee to require all papers read at this meeting to be handed in before the first day of January, 1890.

3. The papers read in 1890 shall be in the hands of the publication committee within two weeks after the meeting, and if such papers are not handed in, the abstracts only shall be published in the proceedings.

4. A strenuous effort shall be made to get the proceedings published before the biennial session of the Legislature in 1891.

5. The Academy shall publish a pamphlet, of 500 or more copies, containing a brief history of the organization, its constitution and by-laws, all the former and present members and their residences, with the different classes appropriately designated.

The report of the Librarian, B. B. Smyth, of Topeka, was read, and accepted. The list of accessions to the library contained in this report is printed in Vol. XI of these Transactions.

Most of the general sessions were held in Lewis Academy. One morning session was, by invitation, held in the chapel of Garfield University. The evenings were occupied as follows: Thursday evening an address of welcome was delivered by Rev. J. D. Hewitt, President of Lewis Academy, and a reply for the Academy of Science was given by Prof. G. H. Failyer. President Dinsmore, gave as the retiring address, an illustrated lecture on "A Wonderful Structure." Friday evening was devoted to an exhibition of microscopes, microscopic appliances and work — the whole forming an exceedingly creditable display. During the meetings fourteen names were added to the list of members.

The annual election of officers resulted in the following choice:

President — G. H. Failyer, State Agricultural College, Manhattan.

Vice-Presidents — D. S. Kelly, State Normal School, Emporia; F. W. Cragin, Washburn College, Topeka.

Secretary — E. H. S. Bailey, State University, Lawrence.

Treasurer — I. D. Graham, State Agricultural College, Manhattan.

Librarian — B. B. Smyth, Topeka.

Curators — A. H. Thompson, Topeka; Robert Hay, Junction City; T. B. Jennings, United States Signal Service, Topeka.

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On Saturday, by invitation of the citizens of Kingman, in a special car provided by the people of Wichita, the Academy went to Kingman and inspected the various salt plants and other industries of the city. A public meeting was held at which a number of addresses were made, and appropriate resolutions were passed.

The Academy voted to hold its next meeting at Lawrence, in October, 1890.

On the following pages will be found papers read at this meeting.

PAPERS.

NOTES ON THE OCCURRENCE OF GOLD IN MONTANA.

BY J. R. MEAD, WICHITA.

"Surely there is a vein for the silver and a place for gold where they fine it."

Such are the words of the wise and patient Job, in Holy Writ. I think the translators should have put a "d" to the word "fine," reading, "a place for gold where they *find* it"—for gold is found in most unexpected places; and of this fact the ancient philosopher seemed to be informed.

Gold has long been considered the standard of values by civilized nations. It is more unchangeable in value than any other substance known to man. It is the only yellow native metal; does not oxidize or tarnish; cannot be eaten or touched by simple acids, but alloys perfectly with other metals; and while as generally distributed through the crust of the earth as any other metal, so seldom is it concentrated in any locality, there is never an excess of production. Fortunately our own country, so rich in natural resources, contains as rich deposits of the precious metal as are found in any land upon the earth. These deposits or veins are scattered through the Rocky Mountains and adjacent ranges, from the frozen wilderness of northern Alaska, down through the United States, Mexico, Central America, and South America, to Cape Horn—in fact, wherever the primitive rocks are thrust up through the overlying strata, there gold may occasionally be found.

The writer had the opportunity, the past summer, of visiting several of the placer mines of Montana. I will here explain that a placer mine is a gravel-bed or creek bottom, containing particles of free gold varying in size from the fineness of flour to pieces several pounds in weight, which is saved by washing away the sand and gravel with water. These placer mines were discovered about the close of the late civil war, and produced in the next three or four years more than $100,000,000 of gold, at the time of our country's greatest need. No machinery was employed other than manual labor, with sluice-boxes sawed by hand from native timber, and pick, shovel, and pan.

These exceedingly rich deposits were found in the tertiary and more recent gravels, in the gulches and former water-courses, and glacial beds, which had their sources near the summit of the main mountain range, or its outlying spurs. Many of the richest gravel deposits were found on the benches and bars, 20, 40 or 100 feet above the present streams, where the former river had impinged upon a hard point of country rock, deflecting its course towards a more yielding material. The consequence was a sweep or current which formed a "bar" whereon the gold effected a lodgment; while the main channel of the stream was scoured by the rushing waters until another obstruction, or an expansion of the stream, formed other "benches" or bars during the period of the erosion of these gulches. (I will here explain that miners call every ravine or creek bearing gold, a gulch.) A much larger volume of water flowed than now, consequently the bars of that period are at the present time high above the present water level.

In some instances, where a narrow gulch was confined between narrow walls, the rushing waters carried the broken fragments of gold-bearing quartz, along with gravel and sand, many miles from its source, and far out into the broad valleys, spreading this detritus over hundreds of acres. The loose gold, with a specific

gravity of 19.3, usually found its way to the bed-rock, while the fragments of quartz, mixed through the gravel, in the course of untold ages, oxidized or crumbled into sand, leaving the gold free, scattered through the entire mass of gravel, sand, and clay.

The matrix from whence came these streams of gold seems to be the mineral veins high up the mountains in the granite rock. These veins vary in width from the thickness of a knife-blade to many feet, and extend down into the great unknown. Though once exceedingly rich on the surface, they are now, owing to the rich outcrop wearing away, often worthless. Gold veins usually decrease in richness with depth, and are filled with pyrites or sulphide ores of iron—some of them containing lead, silver and copper—but iron pyrites seems to be the home of gold. Where veins lie between walls of silurian rock they are usually filled with quartz, which frequently contains the precious metals.

I will not now discuss the question how or when these cracks in the cooling crust of the earth became filled with vein matter, rich in metals, nor why in one locality there should be a vein immensely rich in gold, in another locality rich in iron, or silver, or copper, or lead, or all combined, with a hundred between containing nothing of value; nor why these veins have a uniform course north of east and south of west, while the mountains zig-zag in every direction.

Gold evidently crystallized upon the surface of some of these veins at the time of their formation, in masses of which we have little conception. Tons of coarse gold were taken from the gulches of Montana in early days. These rich outcropping veins were cut through and broken down by down-pouring torrents of water, always seeking a lower level. Then after a time came the glacial epoch, which covered the mountains with vast masses of ice, crushing and grinding down the rugged elevations, shoving boulders, gravel, sand and clay down the slopes and ravines, to be again rearranged by the rivers formed from the melting ice.

The variety in nature is infinite; no two gulches yield exactly the same character of gold. It varies from twelve to twenty dollars per ounce in value. Silver is its most common alloy; it is also occasionally coated with iron or copper oxide. Some gold found on the Yellowstone river is black from a coating of copper. Alder Gulch, a narrow trough between mountains thirty miles long, yielded sixty millions of gold in a few years; also quantities of garnets worthy the lapidary's skill.

Ten-Mile Placers contain quantities of stream tin, and also white crystals of topaz. Carpenter's Bar abounds with sapphires and spinel rubies equal to those found in the Orient. The bars of Ophir Gulch are full of chalcedony, with an occasional diamond. The bed-rock and bars of this gulch are compact yellow clay, faulted in places, and containing strata of gravel of much older geological age, and different material from the gold-bearing gravels of the surface, while Hard-Scrabble Diggings was on a gentle slope in a great valley, containing nuggets only in the surface soil. These were gathered by a plow made from wagon-tires, turning over the soil in the fall, and in the spring washing it away with water from the melting snow, leaving the nuggets to be picked up by hand. The gold of Cañon creek in form and size resembles melon seeds.

The very rich, easily-worked placer mines of Montana are mostly exhausted, but there are many millions yet to be obtained by improved appliances and expensive ditches to bring a supply of water, without which a placer mine is worthless.

ON THE CLASSIFICATION OF THE SENSATIONS OF SMELL.

(Critical.)

BY W. S. FRANKLIN, STATE UNIVERSITY, LAWRENCE.

The theory of the specific energy of the nerves is, that to each quality of sensation there are specific corresponding elements of the nervous system. The end organs of these elements are so grouped and conditioned for each of the special senses as to be exposed with advantage to a particular class of external stimuli. However, any specific nerve group leads to the corresponding sensation when disturbed by any physical means whatever. We think, then, of quality of sensation as due to the particular nerve-cells that are excited, and not to the quality of the excitement; indeed, all nervous activity seems to be alike in kind.

Not only are the nerve elements of each of the five special senses specifically distinct, but also some of the single senses comprehend a number of distinct groups of specific nerve elements, each leading to a sensation more or less distinct. Thus the sense of touch includes at least two separate senses, viz.: the sense of pressure or of touch proper, and the sense of heat, each depending upon specific corresponding nerve elements. There is also some reason for believing that the sensation of cold corresponds to the excitement of a group of nerves distinct from those leading to the sensation of heat.

The sense of sight depends upon three specific groups of nerves. Their action, however, is at variance with the above statement of the law of the specific energy of the nerves, for a combined excitement of the three produces a single sensation of color instead of three distinct, simultaneous, corresponding sensations; indeed, that color sensations are triply manifold, is due to the fact that quality of color depends upon the mixed excitement of these three specific groups. That this fact does not weaken the theory of the specific energy of the nerves, is evident when we consider that *any sensation of particular significance tends to assume a specific character as perceived by consciousness;* indeed, any sensation, even if brought about by the combined action of separate specific nerve elements, is perceived as a unit if it has enjoyed a significance as a whole during our entire experience as a species, and if there has been no occasion for the analysis of it by the higher centers (which in fact may be impossible). This manner of attainment of a specific quality by a sensation must depend upon the nervous organization in the higher centers, together with a specific cross-connection with the cells of the subordinate centers upon which depend the more general qualities of the sensation in question.

To whatever extent the theory of the specific energy of the nerves be true, it is justifiable to assume that the quality of the sensations of smell depends upon the action of specific nerves. The question remains whether the number and quality of the sensations of smell depend upon the variable and mixed excitement of a few specific nerve groups as in the case of color sensations, or whether there may be a large number of specific nerve groups corresponding to as many characteristic odors, and also whether the sensations of smell form a continuous manifoldness, and are capable of systematic arrangement as are colors, or whether they are more or less discrete and do not admit of such an arrangement.

It seems that this question may be answered by considering the nature of the external stimuli active in the sense of smell, as follows:

Let us assume that the number and quality of smell sensations are dependent upon the mixed action of but few specific groups, so that so far as the *apparatus* of smell is concerned, it is possible for the sensations of smell to form a continuous manifoldness of few dimensions; but the external stimuli of smell are discrete, and

some of the mixed excitations of these assumed nerves of smell must be outside of our experience, and consequently the corresponding sensations do not exist, and they would probably be found wanting even if by any artificial means the mixed excitement in question could be produced. Considering the discreteness of the chemical properties of compounds, it seems questionable whether a number of specific end organs could, by each responding more or less to the action of different compounds, give mixed excitements characteristic of these compounds.

Hence it seems that the sensations of smell must form a discrete manifoldness in any case, and it seems also that there must be a large number of specific groups of olfactory nerves, each corresponding to a characteristic odor forming an element of the above manifoldness, though probably each characteristic odor may be the nucleus of a limited region of continuity.

The existence of a large number of specific nerve groups is not without example among the several senses. For the auditory apparatus comprehends as many as sixteen to twenty thousand specific elements, each with an end organ adapted to the disturbing influence of a particular case of external stimulus. However, in any case the arrangement of a large number of specific end organs so as to prevent confusion is a difficult problem (remembering that the strongest argument in a case like the present is to show the possibility). Histology, indeed, recognizes but one type of end organ in the *regio olfactoria*, but we must remember that the character of the external stimuli active in the sense of smell requires the distinctive feature of these end organs to depend upon molecular structure, so that the microscope cannot distinguish between them. On the other hand, the character of the external stimuli of sound requires form to be the distinctive feature of the specific end organs of hearing. The present usefulness of the sense of smell to man scarcely seems to warrant the existence of a highly-organized apparatus of smell, yet there can be no doubt but that there may have been a period in our development when this sense was vastly more important. Indeed, there are indications of the degeneration of this sense in man.

All the experimental results in this field, although perfectly powerless in the direction in which the investigators have attempted to apply them, viz., toward the establishment of a systematic arrangement of odors, are cumulative evidence of the discontinuous nature of the sensations of smell, and of the existence of a large number of independent (nearly) groups of specific olfactory nerves.

Then, too, the fact that contrast effects are not known in odors as they are in colors, and the fact that fatigue for one odor leaves the sense delicate for another, both partake of the nature of positive evidence in this direction. If the large amount of patient and careful research in this field had been applied as evidence of this view of the subject, it might not have been so entirely fruitless, although it is difficult to see how positive evidence in this direction is to be reached, at least until histology is able to attack molecular structure, and chemistry has cleared away the mist still hanging over the nature of the "odorous particles."

NOTES ON MAGNETIC DECLINATION IN KANSAS.

BY PROF. F. O. MARVIN, STATE UNIVERSITY, LAWRENCE.

By Kansas law, each county surveyor in the State is required to observe the declination of the magnetic needle four times in each year—in the months of January, April, July, and October—and to report the results to the office of the Secretary of State and to the Chancellor of the University. No compensation is fixed for the

performance of this duty, nor is any penalty attached for a non-compliance with the law. The law is therefore inoperative in most cases. There are on an average but fifteen to twenty county surveyors in the State each year that pay any attention to the matter. A record of such observations as have been made has been kept at the University for the last ten years. During this time fifty-seven of the one hundred and six counties of the State have made reports, some of these reporting every year, though the majority have reported in but one or two years out of the ten. The surveyors of Ness, Hodgeman, Edwards, Stafford, Rooks, Osborne, Russell, Ellsworth, Clay, Saline, Greenwood, Leavenworth and Miami counties are credited with the largest number of observations.

Some of the reports bear evidence on their face as to the poor quality of the observations. In a few cases a surveyor has reported over one and a half degrees difference between the quarterly observations of the same year. The same county has furnished observations in succeeding years that differ by a degree and a half, the latest observation being the larger. The apparent discrepancies can be accounted for in several ways: the surveyor may be the wrong man for the place, or he may be inexperienced; the reports may be made up through guess-work without any observations on a carefully-laid-out meridian; observations may be taken at different points in the county, and may be affected by local attraction; one surveyor may use a different instrument from the one used by his predecessor. It is a difficult matter then to take these reports, to compare them, to give more weight to some than to others, to reject some as unworthy of confidence, and to deduce an estimate of the rate of change and to construct an isogonic chart for the State. But I have attempted to do this, hoping that in the future a larger number of yearly reports may reach the University, and so forming a better basis for comparison.

The declination of the needle ranges from about 8°30′ in the southeast corner of the State to 12°30′ in the northwest corner. The isogonic lines in general trend a little to the west of south. The 9°30′ line runs through the northwest corner of Brown county, the western part of Jackson and the center of Shawnee counties; then bending eastward crosses the western parts of Franklin and Anderson counties; then returns to its westward trend, crossing Woodson county at the southeast corner, Wilson county through its center, and Chautauqua county through its eastern part. The 10° line approximately cuts the following points, viz., Belleville, Concordia, Clay Center, Fort Riley, Council Grove, the west line of Lyon county, a point half-way between Eureka and El Dorado, and leaves the State with the Arkansas river. The 11° line cuts Mankato, Osborne, the west line of Russell and Barton counties, Larned, and crosses the Arkansas river a few miles east of Dodge City. The 12° line cuts the northwest corner of Norton county, the southeast corner of Decatur county, the east line of Thomas county, the center of Gove county, the northwest corner of Lane county, and passes near Scott City, Lakin, and Ulysses. The intermediate lines are approximately parallel to the lines described, except those lying between the 10° and 11° lines. Around Ellsworth there is a closed line of 10°, forming an elliptical figure with its longest axis in a direction 45° east of north, and which covers nearly all of Ellsworth county. Around this figure are closed lines of 10°30′, 10°45, and perhaps of 11°30′. If we were to follow the Kansas and Smoky Hill rivers across the State, we would find the declination about as follows, viz.: Lawrence, 9°5′; Topeka, 9°20′; Manhattan, 9°55′; Junction City, 10°10′; Abilene, 10°20′; Salina, 11°30′; then decreasing to 10° at Ellsworth; then increasing again to 10°50′ at Russell; Hays City, 11°20′; Wakeeney, 11°40′; Gove, 12°; Wallace, 12°25′.

The rate of change as nearly as I can estimate it is about three minutes each year, the East declination decreasing. At Phillipsburgh. from 1865 to 1882, the total change was 51′, or 3′ per year. At Seneca the total change from 1855 to 1880 has

been reported as 30′, or 1′10″ per year. At Lincoln Center, from 1874 to 1884, the change was 33′, or 3′18″ per year. Observations extending over shorter periods, when coupled with these, make me think that the rate is as above stated, 3′ per year.

In order to secure results that can be compared, there ought to be established at each county seat a *true* meridian, permanently marked. The lines should be laid out carefully by competent persons, and with better instruments than are usually found in the hands of surveyors. The State by an appropriation could well provide for the actual expenses of such work, and the University could furnish the instruments and the men to do it. Then each surveyor should receive from the county a just compensation for his labor in taking the quarterly observations, and these should be taken with more system than is now done. To call the attention of the surveyor to the present law is of no avail, as the University has proved by sending out yearly a table of "Pole Star Times" and asking for compliance with the law.

NOTE ON THE SECOND SETTING OF CEMENT.

BY B. J. DALTON AND F. O. MARVIN, LAWRENCE.

It is proposed to study the action of cements, which, after having set, have again been mixed up into mortar and allowed to permanently harden. Some masons claim that this second setting of the cement increases its strength. On looking up what has been written on the subject, we find that modern engineers in their specifications demand that mortar which has set shall not be used. Yet we have found no statement of reasons, nor any record of tests comparing the strength of samples of the same cement; some having set once and others twice. We shall at this time report progress only, as too small a number of briquetts have been broken so far to enable us to draw safe conclusions. A full description of methods and results is then reserved for a future report, merely noticing now that the indications are that, with the cements used, a second setting injures their strength.

A PRELIMINARY STUDY OF "HOT WINDS."

BY SERGT. T. B. JENNINGS,
Signal Corps, Ass't Director Kansas Weather Service.

In the study of this phenomenon, the first question to decide is, what are "hot winds"? A careful search through all the meteorological works at my command fails to reveal any definition. Shall every warm wind that proves a destructive blast to vegetation be termed a "hot wind"? I use the term "proves" under protest, because there are other conditions the effects of which are sometimes ascribed to "that hot wind."

In 1866, my first year in Kansas, we had in the eastern part of the State some "hot winds." During that summer our prevailing wind for about 60 days was southwest, and in that time we had a hot wind of eight days' duration, each day the temperature in Franklin county rising to upwards of 100°, and not falling below 80° during the nights. On the fourth day a long-range thermometer was laid across two sticks about six inches above the ground, on a path where there was not even dead grass. Its mercurial column rapidly extended, until it finally reached the limits of the instrument, 140°, when, after enduring the confinement for a short period, it found escape by bursting the bulb, and ended the experiment. The time was

somewhere about 2 to 3 P.M. Still I would not require a wind to reach the temperature of 140° to be honored with our title. But after studying this matter more or less for some time, it has been decided for the purposes of this paper that winds must reach the temperature of 98° to be designated as "hot winds."

After a correspondence, extending through the past winter, on this matter, between the meteorologist of the U. S. Geological Survey and the Kansas Weather Service, it was decided in the spring to issue a joint circular and a blank form for report of these winds. The following is the circular:

(*The United States Geological Survey, in coöperation with the Kansas Weather Service.*)

WASHINGTON, D. C., TOPEKA, KANSAS. } June 15, 1889.

DEAR SIR: The widespread prevalence of "hot winds" during recent seasons, attended by the partial or complete destruction of the vegetation in their path, has awakened the attention of agriculturists and meteorologists to the need of a better knowledge of their origin and extent, with a view to the possible amelioration of their destructive effects. Many theories have been advanced as to their "cause and cure," but more accurate and reliable information regarding them seems necessary before giving adherence to any.

The U. S. Geological Survey, in coöperation with the Kansas Weather Service, purposes to collect the requisite statistics of the "hot winds" of the present season, and to this end requests voluntary reports of these phenomena upon blanks which have been prepared for the purpose. A supply of these blanks, with return envelopes, accompanies this letter. The scope of the information desired is indicated by the questions on the blanks.

The preparation of these reports, if made as full and complete as circumstances permit, will be a valuable service to the bureaus undertaking the investigation, and it is hoped will result in practical benefit to the territory affected.

The general results of the work will be furnished to each observer.

T. B. JENNINGS, (Signal Corps,)
Assistant Director Kansas Weather Service.

GEORGE E. CURTIS, Meteorologist,
U. S. Geological Survey.

(*U. S. Geological Survey, in coöperation with the Kansas Weather Service.*)

REPORT OF HOT WINDS.

Station ——, county ——, State, ——.

Give distance and direction from nearest post-office, ——.

Dates of discontinuance, ——.

Time of beginning, ——. (Give time used—whether R. R. or sun.)

Time of ending, ——.

State whether continuous or discontinuous—especially whether ceasing during night.

Direction from ——. (Nearest point north, northeast, east, southeast, south, southwest, west, or northwest.)

Force—Give by scale number the prevailing force, ——; the maximum force, ——; the time of maximum force, ——.

Temperature, ——. (Give highest temperature in the shade.)

Remarks. (State effects on vegetation, and any other facts pertinent to the subject.)

A copy of the blank form for "Report of Hot Winds" also accompanies this paper. Criticisms are invited, as it is the pioneer in its line; suggestions will be thankfully received, and valid improvements adopted.

In answer to this circular a number of "hot winds" have been reported. During July these occurred on the 5th, 6th and 7th, 15th, 16th and 17th, and 26th and 27th, that of the 15th, 16th and 17th being the most extensive and disastrous.

A résumé will be interesting. On the morning of the 5th there is an area of diminished pressure central near the Black Hills, in Dakota. Its indraught extends to the lake region on the east and to Texas on the south. At Bismarck the wind is northeast and the barometer 29.56; at Rapid City the wind is west and barometer 29.52; while over Lake Erie the barometer is 30.20, and in Texas 30.06. By the time of the evening observation, 7 P. M. central time, a change has appeared on the Government maps. A *hot wave* (remember the time of day—7 P. M., that is after 6 P.M., actual time) extends from North Platte, Neb., to Fort Custer, Mon., covering the southwest half of Dakota, with temperatures as follows, viz.: North Platte 94°, Val-

entine 96°, Huron, Dak., 94°, Bismarck 90°, Fort Sully 98°, Rapid City 92°, and Fort Custer 90°. An area of lower barometer has developed in the mountain regions of Idaho, Montana, and Wyoming, or has advanced from the west and is now central in that region, drawing the wind from the south across Kansas and Nebraska at from 16 to 24 miles per hour. During this afternoon occurred some *hot winds* in the western counties of our State. In Morton, Stevens, Grant and Stanton the temperature reached 99°, in Trego and Gove 100°, and in Thomas 102°. At North Platte, Neb., it reached 102°, and at Valentine 106°.

On the morning of July 6th this area of low pressure has moved southeastward, and is now central in the northwestern part of Nebraska and southwestern part of Dakota. This being Saturday, no afternoon map was issued. The 7th being Sunday, no morning map was issued, but the afternoon map shows the low pressure divided, a part being central in northwestern Iowa, and the other over the Panhandle of Texas, while the general current of the wind over Kansas is from the southeast. The maximum temperatures of this day were lower in Nebraska than in Kansas. At Dodge City it was 94°, at Gibson 105°, at Lisbon (Gove county) 100°, at Offerle (Edwards county) 98°, at Englewood 97°, at Hugoton 97°, and at Colby 98°. The general current of the wind over Kansas was changed to east and northeast, responding to an area of low pressure over the Panhandle and New Mexico.

The rain of the 8th, and the high pressure following, materially lowered the temperature for the next few days.

An extensive area of low pressure in the mountain regions on and after the morning of the 12th, kept our winds southerly until the night of the 17th–18th, the maximum temperatures of the 17th, being the maximum for this hot wave, were as follows: North Platte 100°, Colby, Kansas, 103°, Lisbon 108°, Gibson 114°, Dodge City 100°, Offerle 103°, Hugoton 100°, Englewood 101.5°, Fort Elliott, in the Panhandle, 102°, Fort Sill, Indian Territory, 96°, and El Paso, Texas, 100°.

But as this paper is only preliminary to a fuller discussion of this subject at our next annual meeting, its object at this time being to show the line and method of research, its purpose is deemed fulfilled.

SOME TESTS OF CEMENTS MANUFACTURED IN KANSAS.

BY E. C. MURPHY, STATE UNIVERSITY, LAWRENCE.

The tests which form the basis of this paper were made by the writer at the State University during the month of July, 1889.

It was the writer's intention to test all the cements manufactured in Kansas. Cement is reported as having been manufactured at Fort Scott, Kansas City, Manhattan, Alma, and Topeka. Only those manufactured at Fort Scott and Kansas City could be found in the market at this time, and hence they are the only ones tested.

In order to get the relative value of these two cements, and their value compared with a standard cement, I have tested with them, under the same conditions, a German Portland cement.

Much care has been taken to have the conditions under which the tests were made, the same for each cement. To this end the following method of testing was used: The water used in mixing the cement, as well as that in which the specimens were placed, was left in the testing-room (one of the large rooms of the main University building) for 24 hours before using, in order to have a uniform temperature. A bricket of each cement was then mixed to as nearly as possible the same degree of plasticity; the mold in which the bricket was made was filled, placed on a marble

slab and left until the cement was stiff enough to be taken out of it; after 24 hours in air the brickets were placed in the water box and left until broken; they were broken immediately after being removed from the water.

The Kansas City and Fort Scott cements were purchased from a cement dealer in Kansas City. The Portland is an imported cement purchased from Grovenor & Son, Lawrence, Kansas.

One hundred and fifteen specimens were made, one hundred and five of which were broken, and go to make up the estimates. They were broken in an Olsen cement-testing machine of 2,000 pounds capacity.

The sand used in making some of the brickets is Kaw river sand. It was sifted through sand sieve No. 20, 400 meshes (Stubb's No. 28 wire) to the square inch. The portion which passed through the sieve was used.

The fineness was tested by weighing one pound of the cement, sifting it through cement sieve No. 50, 2,500 meshes (Stubb's No. 35 wire) to the square inch, and weighing the portion which did not pass through the sieve. The ratio of the weight of the portion which did not pass through the sieve to one pound, reduced to per cent., gave the fineness.

Table I gives the percentage of each cement which did not pass through cement sieve No. 50.

TABLE I.

NAME.	PER CENT.
K. C.....	27.3
F. S.....	23.5
P.....	7.8

The specimens used in the tensile tests were of the standard size and shape. Their smallest section has an area of one square inch.

Table II gives the name, age, number of specimens of each kind broken, and the breaking load of neat cement.

TABLE II.

NAME.	AGE.	NO. SPECS.	BR. LOAD.
K. C.....	1 day.....	3.....	7
F. S.....	"	3.....	25
P	"	3.....	75
K. C.....	7 days.....	6.....	17
F. S.....	"	6.....	32
P	"	6.....	174
K. C.....	14 days.....	4.....	34
F. S.....	"	4.....	66
P	"	4.....	237
K. C.....	21 days.....	4.....	39
F. S.....	"	4.....	87
P	"	4.....	282

Table III gives the name, age, number of specimens of each kind broken, ratio of sand to cement, and the breaking load of section.

TABLE III.

NAME.	AGE.	NO. SPECS.	RATIO.	BR. LOAD.
			s. c.	
K. C.....	7 days.....	3.....	1:1.....	6
F. S.....	"	3.....	1:1.....	7
P.....	"	3.....	1:1.....	107
K. C.....	"	6.....	2:1.....	1
F. S.....	"	6.....	2:1.....	4
P.....	"	6.....	2:1.....	49

The specimens used to test the transverse strength were rectangular prisms 14″x1½″x1″. They were broken on supports 12″ apart, by a weight in the center.

Table IV gives the name, age, number of specimens of each kind broken, and the breaking load of the above-described prisms of neat cement.

TABLE IV.

NAME.	AGE.	NO. SPECS.	BR. LOAD.
K. C.....	21 days.....	2	4
F. S.....	21 days.....	1	15
P.....	21 days.....	1	49

The specimens used in compression tests were sawed and ground from the broken rectangular prisms. Table V gives the results for these tests.

TABLE V.

NAME.	AGE.	NO. SPECS.	BR. LOAD.
K. C.....	23 days.....	6	230
F. S.....	23 days.....	6	829
P.....	23 days.....	6	1,908

No attempt has been made to measure accurately the hydraulic energy or quickness of setting of these cements, for lack of suitable apparatus. I may state, however, that the time required for the Kansas City and Fort Scott cements to harden sufficiently to be taken out of the mold without breaking, was from two to three hours. The Portland required from four to five hours.

The Fort Scott cement is being manufactured by two companies. The old works are operated by the Missouri, Kansas & Texas Cement Company; the new works are operated by the Fort Scott Cement Manufacturing Company. The latter company has six perpetual kilns, one Blake crusher, and a pea mill to aid the crusher. The capacity of the works is 500 barrels per ten hours.

The Kansas City Cement Works Company was incorporated December 6, 1884, and has been in successful operation for four years. This company has about

eight perpetual kilns. It has been found necessary, in order to make the cement satisfactory, to bring rock from Milford, Kansas, and mix with the rock obtained near the works. Very little has been manufactured at these works during this year.

The cost per barrel at Lawrence of the three cements tested is: Kansas City, $1.65; Fort Scott, $1.65; and Portland $4.50.

NOTE ON THE OVIPOSITION OF A WOOD-BORER.

BY PROF. E. A. POPENOE, STATE AGRICULTURAL COLLEGE, MANHATTAN.

The beautiful beetle known to the entomologist as *Tragidion fulvipenne* is not common enough to have received a vernacular name, and at no time have we had a surplus stock of specimens in our collections. Being on the watch for facts in its life history, I observed with interest that in the warm days about the end of September, my wood-pile was the center of attraction to a number of these beetles. Noting that all the individuals were females, and that, though at first seen only flying, they presently alighted with evidence of an earnest purpose, I watched them more attentively. They seemed to be attracted specially to the smooth sticks of round wood, of a species of oak, without much doubt the chestnut oak, as this is the only smooth-barked oak abundant in the vicinity of Manhattan. Over these sticks they crawled, paying little regard to my presence, their bodies close to the wood, their sensitive antennæ carried forward and constantly vibrating, as they investigated apparently every inch of the surface. The evident object of their search was suitable spaces for the deposit of their eggs, and though I watched with some care during my noon-hour for several days, I did not succeed in observing the beginning act in oviposition. I was fortunate enough to see two females that had not completed their work, however, and so was able to discover the eggs, which I might otherwise have failed to find at all. When detected in oviposition, the females were standing on the smooth bark, transversely to the stick, their bodies close to the surface, their antennæ bent under at the tips, which were touching the bark, and the broad tip of the abdomen closely appressed to the surface over which the insect stood. The close contact of the motionless tip of the abdomen to the bark, prevented my noting the exact mode of placing the egg, and presently, becoming somewhat impatient, I lifted a beetle from position; and, to my surprise, instead of an opening in the bark as I had anticipated, I saw a tubercle simulating so closely in appearance and color the corky outgrowths common on the bark of the chestnut oak, that I was at first inclined to believe it one of these, and to question the purpose of the female in maintaining so long the position described. On an examination of this tubercle, however, I found it to be hollow, and within it, lying on the bark, with no puncture or abrasion in the latter to be seen, was an oblong egg of a translucent, dull white surface, smooth and without markings so far as I could see with a pocket-triplet of good definition. This egg was sufficient in size nearly to fill the hollow tubercle, or egg-case, as I may now call it. The egg-case is rather regular, elliptical, strongly convex, measuring about one-sixteenth of an inch in length. Under the microscope the case appears on the surface to be made up of scales of the thin external layer of the oak bark, intermingled with glistening particles, as of dried mucus. The case is at this date unchanged, and no sign of the hatching of the egg is yet visible. I have been unable to find the record of similar habits in oviposition in any of the *Cerambycidæ*. Commonly the eggs are either laid under scales or in cracks in the bark, as with most of the wood-borers, or in a rough fissure

made by the insect herself for the purpose. I have found no reference to the op position of the species of *Elaphidion*, our common allies of *Tragidion*.

The beetle in question is attracted to some coarse flowers, as the *Silphium perfoli atum*, or is destructive to ripe fruit, as peaches, by gouging into the tender fruit, th juices of which are a favorite food. I have also observed them eating the flesh of a ripe watermelon in company with other fruit-boring insects, the cetonians, wasps and flies.

A STUDY OF THE ALBUMINOIDS.

BY PROF. L. E. SAYRE, STATE UNIVERSITY.

[*Abstract.*]

For several years past various attempts have been made to concentrate and bring to a convenient form for administration as remedial agents the digestive principles contained in the gastric juice and pancreatic fluid. While the efforts in this direction have thrown much light upon the nature of these principles, their exact constitution has not been studied, for the reason that no one seems to have as yet accomplished the difficult task of isolating them.

The two processes adopted by pharmacists at the present time for the purpose of making medicinal pepsin are about as follows: One is known as Scheffer's process, by which the pepsin is dissolved out of the mucous lining, along with other albuminous substances by means of slightly acidulated water. The resulting liquid is treated with chloride of sodium, which causes a light, flocculent precipitation of these substances. The precipitate, collected, washed, and dried, constitutes this form of pepsin, which appears in the market in the form of a light-brown powder. More usually it comes as saccharated pepsin; this is a white powder composed of the above so-called pure pepsin and a liberal quantity of sugar of milk. It is slightly soluble in water. The kind of pepsin known as crystal, flake or scale pepsin is quite a different article in appearance and composition. It is composed largely of peptone holding in its substance a good deal of peptic power. In preparing it advantage is taken of the peculiar influence which heat exercises, in the presence of acidulated water, over the mucous lining of the stomach. The finely-chopped mucous membrane is digested in a very mildly-acidulated aqueous solution at a temperature of 38° C. until the whole is obtained in a viscid solution. This is filtered, neutralized, and evaporated at a temperature not over 40° C., until a thin, transparent scale is formed. This product comes in market in yellowish, transparent laminæ, very soluble in water. It also appears in the form of a white powder in the saccharated form.

The process of manufacture of pancreatin upon a large scale for the market has been kept pretty closely as a trade secret. It appears in the market in the form of a yellowish-brown powder, almost entirely soluble in water, and of a disagreeable odor. It has the special property of digesting albuminous substances in an alkaline solution. Pepsin will accomplish this only in acid solutions. Its application as a medicinal agent is especially valuable in certain forms of infantile digestion and certain depressed conditions of the digestive functions in adults, where a milk diet is indicated. Pancreatin is used in these cases to dissolve (digest) the caseine of the milk. The predigested milk becomes a very nutritious substance, and is easily assimilated by a very feeble stomach.

The method I have used for the purpose of preparing pancreatin is in substance as follows: The finely-chopped pancreas is macerated for twenty-four hours in a mixture of equal parts of glycerine and water, using one fluid ounce of the mixture

to each ounce of the gland. The liquid is pressed through a cloth strainer, and a precipitate obtained by the use of strong alcohol. This yields a light-yellow product with an unctuous feel, not very freely soluble in water. My own experiments for the past year have been directed principally in the direction of a study of these two so-called principles—pepsin and pancreatin. I have attempted, in the case of pepsin, to obtain a highly-concentrated preparation by the elimination of foreign albumens, and in the case of pancreatin have tried to verify or disprove, to my own satisfaction at least, some of the statements of writers regarding its properties. These properties are about as follows:

1. Property of converting albumen into peptone.
2. Converting starch into sugar.
3. Converting fats and oils into emulsions.
4. The digesting of the caseine of milk.

It is beyond the scope of this paper to give in detail the numerous experiments, and therefore I shall confine myself to a brief summary of results.

Before giving this summary, it may be well to state that it is a very difficult matter to obtain a pepsin which will remain permanent—a grain of which will digest 1,200 to 1,500 grains of coagulated albumen. To obtain such an one, very careful manipulation is required, and the result is more readily accomplished by following the Sheffer process.

I have found that if the acidulated solution of the mucous lining be treated with from 2 per cent. to 3 per cent. of choloride of sodium and allowed to stand, there appears to be a precipitation of a substance which has a viscid, mucous-like character, and is odorous. While it has weak peptic power, the latter seems to be merely an admixture. I could not say at present that it has other properties than that ascribed to pepsin, but it appears different. The principal point I wish to call attention to is that there is left in solution a product which seems to have greater power than if it were precipitated along with the substance above mentioned. The solution remaining after the removal of the first precipitate was saturated with common salt, and the precipitate (second precipitate) has, when washed and dried, a digestive power in excess of what is usually known as pure pepsin. It is less viscid, being much more granular, lighter in color, and almost free from odor. At this time I am not prepared to say what importance may be attached to these results, but to me it indicates that this treatment has yielded a more concentrated pepsin by the removal, or partial removal, of an albuminous substance foreign to pepsin.

I have endeavored in another line of experiments to ascertain which part of the mucous lining of the stomach secretes the most pepsin. For this purpose I have taken and separated the lining into three parts:

1. The loose viscid magma.
2. The thin cuticular layer.
3. The sub-cuticular layer which joins the muscular coat of the stomach.

These were all placed in macerating vessels and treated in the same manner, using substantially the Sheffer process. To my surprise I found that the macerate of the first mentioned produced a product of very weak peptic power, the thin cuticular layer produced a product of extraordinary strength, the third one of intermediate power. These experiments have been repeated a number of times with the same results. I propose to repeat these experiments and endeavor to arrive at some positive conclusion concerning them. As a summary of my work in pancreatin, in which I was aided by Mr. F. L. Abbey, in the pharmaceutical laboratory, I would state the following as my conclusions:

1. One grain of pancreatin digests eighty grains of coagulated egg albumen.

2. Pancreatin acts most readily upon albumen in a slightly alkaline medium, is less active in a neutral solution, and is slowly rendered inert in an acidulated medium.

3. Pancreatin is inferior to pepsin in its action upon coagulated egg albumen.

4. One grain of pancreatin in a neutral medium dissolves 64 grains of lean meat, and in alkaline solutions 140 grains are dissolved. Alkalinity favors meat digestion. Pancreatin is equal to pepsin in its action upon meat.

5. One grain of pancreatin will curdle and convert into peptone the casein in 900 to 1,000 grains of milk.

6. Pancreatin is peculiarly active in the digestion of milk.

7. One grain of pancreatin converts 100 grains of starch in one to two hours, but requires from four to six hours to convert it into sugar. Its diastatic power is increased by alkalinity.

8. One grain of pancreatin will emulsify 50 grains of cod liver oil, and, more completely, an equal quantity of lard. Alkalinity is almost essential to complete emulsification of fats.

9. Pancreatin is slowly and incompletely soluble in water.

10. While pepsin is more powerful in its specific action than pancreatin, the latter has such a variety of functions that it cannot be regarded as inferior to pepsin.

A NEW FRAME FOR THE POCKET MICROSCOPE.

BY PROF. L. E. SAYRE, STATE UNIVERSITY.

A simple microscope—a "pocket lens" as it often and preferably is called—is indispensable to every one who has a taste for "nature studies;" not only because of its special quality of magnification as compared with the compound microscope, but because it is always ready for the examination of anything picked up along the roadside, in the fields or woods. It is small, and easily carried in the pocket. It has always seemed to me, however, that this little instrument, useful as it is, does not entirely fill the requirements of the botanist in his out-door and field work; because it is not mounted in the most suitable frame for the purpose of examining the small flowers and parts of the flower. This is especially perceptible when one endeavors to hold in one hand this pocket lens and the object for examination, and with the other endeavors, with more or less deft fingers, to dissect the object—the smaller the object the more difficult it becomes. The position of the operator, to say the least, is very awkward when he attempts an analysis with the ordinary pocket lens. This I have endeavored to overcome in the device I herewith present.* It consists of a long handle, at one end of which is hinged a stem, which can move freely from the socket above as a knife-blade does in its handle. At the extremity of this stem there is inserted a ball and socket joint which is surmounted by a second smaller stem, and this is surmounted by the microscope.

It will be perceived that from this construction the magnifying lenses will have full play, and can be placed in any position while it is being held firmly by the hand. Furthermore, while it is thus being held in any position desired, the thumb and index finger of the same hand are left almost perfectly free to hold any object however minute. At the same time the other hand is left entirely free to operate with dissecting needles or any dissecting botanical instruments necessary for the purpose.

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*Prof. Sayre here exhibited his new microscope frame and microscope attached, and illustrated its merits.

THE MANUFACTURE OF BINDING-TWINE.

BY PROF. L. E. SAYRE, STATE UNIVERSITY.

The manufacture of binding-twine is a subject which has presented itself quite forcibly during the past years to the farmers of the State of Kansas. Everyone knows that the farmers have been obliged to pay an unreasonable price for this article, and the question presents itself, is it feasible for those who would help the agricultural industry, to manufacture binding twine near at home, and thus not only probably reduce the price of this article, but encourage the raising of such vegetable material as would furnish a fiber suitable to the same?

The manufacture of binding-twine, it is presumed, is familiar to all. It may not be amiss, however, to say that the hemp furnishes a fiber sufficiently tenacious for all the purposes of manufacturing binding-twine. It is a product that does well in eastern Kansas, and in the early history of the State yielded handsome returns to the cultivator; but for the want of a home market and the high cost of freighting it to a distant market, it is said to have ceased to yield a profit on its cultivation. It requires a rich soil and heavy manuring, and is an exhausting crop. Yield per acre, 10,000 to 20,000 pounds of hemp; cost, about $10 to break and hackle it.

The oil from the seeds is quite marketable. It has drying properties, though inferior to linseed.

The following table shows the amount raised in the State of Kansas for a few years back:

Years.	*Acreage*	*Pounds.*	*Value.*
1885	232	208,800	$10,400 00
1886	158	110,600	5,530 00
1887	327	228,900	11,445 00
1888	229	167,300	8,365 00

The average yield of fiber per acre in the United States is said to be from 700 to 1,000 pounds.

If the subject became a matter of much interest to scientific men, and if their attention were concentrated upon it, doubtless their investigation would lead to the discovery of plants yielding a fiber of a quality sufficient for all the practical purposes of the grain-binder, and indigenous to Kansas soil.

I may remark incidentally, as a matter of interest in connection with this subject that it is said to have been demonstrated that the cotton stalk, which has hitherto been regarded as waste, contains valuable fiber. A lot of the stalks was recently sent from Arkansas to a factory in New York to be operated on in the same manner as flax and hemp. There were returned about twenty different grades of fibrous material, from coarse strands of the stalk to the glossy fiber as soft as silk. Persons are now engaged in perfecting a machine that will spin the material. The fiber is sufficiently strong to make the best of bagging, as well as cloth as fine as linen. I have no question that the stems of many of our native weeds would be as valuable as the cotton stalk for the same purpose, if they were properly worked up.*

In former years it was customary for the farmers of this State and elsewhere to bind the wheat, oats, etc., with iron wire, which had the serious disadvantage of being a source of considerable injury to horses and cattle, and to the threshing and

*It may be known that there has of late been invented a process of working common straw into binding-twine. This bids fair to revolutionize the whole industry.—L. E. S.

milling machinery. In spite of the greatest care, pieces of wire and nails would get into the machinery, and finally the feed, which, as stated, became a very serious obstacle in the way of using wire. It was customary to use magnets to take out all of the metallic contaminations, and I have heard it stated that it was quite amusing to see the odd pieces of metal that would be taken out by this means—nails, screws, parts of buckles, etc. The magnet was found to be inadequate; the metallic contamination *would* remain in spite of the magnet, and often to such an extent as to render the feed positively dangerous for horses or cattle. Binding twine thus became an absolute necessity for the cereal products.

In 1883 there was started in Lawrence a manufactory of twine. This establishment was at first confined to the making of hemp cordage. The capacity of the mill was 20,000 pounds per day. After a time the idea was suggested that binding twine could be made profitably; and for this purpose a mixture of hemp and "sisal" was used. The name "sisal" is derived from its habitat, Sisal, a part of Yucatan. The fiber is known in the market as sisal-hemp or sisal-grass, and is prepared from the *Agave Americana.*

The feasibility of making this product was arrived at by the following considerations at the time: The company having in charge the above manufactory figured that the sisal could be brought here and made for 8 to 9 cents per pound—wholesaled at 12½ cents per pound. Now the price is 15 to 17 cents per pound, and the market is controlled by what is practically a trust. I may add in passing, that the relation which sisal twine bears to hemp is about the relation of linen thread to cotton—sisal representing the linen. At this time there was made on the product of this factory a profit of 50 per cent. It would prolong this paper unduly to trace the history of this enterprise further; but I will state that the manufactory was discontinued for the reason that the manager was found to be an impractical man, and his financial ability was insufficient to meet the demands of so large a concern. It was just as well that it was discontinued, for the "trusts" would have made its maintenance impossible in a short time. The method adopted by the trust for the purpose of controlling the market in such a case was to negotiate for the purchase of the factory, of its product, or to lease the factory. If neither of these could be accomplished, the trust would "freeze the factory out"—a term well known to the trade.

Speaking with one of the capitalists of Lawrence, I learned that money could be raised now, in Lawrence and elsewhere in the State, to start and help along an industry of this kind.

These are the figures for a mill of $20,000. This amount would cover the cost of machinery as follows: One lapper and comber; one drawing-frame, medium size; two spinning-machines, which spool the thread; one balling-machine—balled from spools. This factory will have the capacity of 15 tons per week, running 24 hours per day. Six men would be required to run such a mill. A capital stock of $25,000 would pay for plant, machinery, and stock. To keep stock ahead, which would be necessary, the bankers would loan on stock in hand.

I should state in closing, that this paper has been written at the request of the Secretary of the State Board of Agriculture, Hon. M. Mohler, who desired me to investigate the matter for his satisfaction.

NOTES ON THE ANALYSIS OF AGRICULTURAL PRODUCTS.

BY J. T. WILLARD, STATE AGRICULTURAL COLLEGE EXPERIMENT STATION.

[*Abstract.*]

The author described several devices which he has found especially useful in the analysis of certain agricultural products. Desiccation in a current of dry hydrogen may be conveniently accomplished by putting the samples in wide-mouthed weighing-bottles, and setting these in a small copper box, which is closed air-tight by wide corks in the top and is connected by glass tubing with the hydrogen generator. This copper box is heated in the water oven. The latter may be raised to the full temperature of the boiling water by fitting a board into the open side of the oven, inside the ordinary door. A T-tube, with two of the openings sealed and having two to six short upright branches, is very convenient for connecting drying-tubes with an aspirator or with a source of dry hydrogen. The drying-tubes are like short, wide test-tubes with a short piece of glass tubing sealed into the bottom. This tubing is of the same size as that used for the upright branches of the connecting tube. The two are connected by a perforated cork. When necessary, the drying-tube may be closed by a cork bearing a short piece of glass tubing drawn to a small opening.

The author determines the water, ether extract and crude fiber in a single sample of a fodder by drying the substance as above described, inclosing it in smooth filter-paper folded into a sack-like form, extracting with absolute ether, and estimating the fiber in the residue.

The foaming, which usually gives so much trouble when a fodder is boiled with the acid and the alkali in the determination of fiber, may be completely controlled by directing an air-blast upon the surface of the boiling liquid in the Erlenmeyer flask. The blast of air may be obtained by supplying the flask with a suitable jet tube, which is connected directly with a source of compressed air; or, as the flask is connected with an inverted condenser, the blast may be *drawn* in by connecting a pump with the upper end of the condenser.

NOTE.—The substance of the paper of which the above is an abstract will be found in the annual report for 1889, of the Kansas State Agricultural College Experiment Station.

AMMONIA AND NITRIC ACID IN RAIN-WATERS COLLECTED AT THE AGRICULTURAL COLLEGE.

BY PROF. G. H. FAILYER, STATE AGRICULTURAL COLLEGE.

[*Abstract.*]

The full and complete results upon this subject are contained in the annual report of the Experiment Station of the College for the year 1889. The analytical work has been largely in the hands of Messrs. J. T. Willard and C. M. Breese, of the chemical department of the College.

The rain has been collected in a gauge the five-thousandth part of an acre in area. This gauge has been in use since March 1st, 1886. The water is measured in litres, and a sample taken for analysis.

The first year the nitrogen existing as ammonia and nitric acid was determined at one operation as ammonia by reducing the nitrates to ammonia by a copper-zinc couple made after W. M. Williams's directions, and nesslerized after distillation. Since March 1st, 1887, the ammonia and the nitric acid have been determined sepa-

rately. A measured volume is made alkaline, and distilled; the distillate is then nesslerized: this gives the ammonia. For nitric acid an additional volume is measured into the flask, and the ammonia boiled off. The residual liquid is made slightly acid by H Cl, reduced by the copper-zinc couple, made alkaline, distilled, and nesslerized. The ammonia now obtained is that resulting from the reduction of nitrates and nitrites.

In Table I is shown, by months, the results for the three years ending February 28th, 1889. The columns under nitrogen give the nitrogen in both ammonia and nitric acid. Ammonia is given as NH_3; nitric acid as HNO_3.

In Table II are given some of the extreme—both greatest and least—proportions between the rain-water and the compounds under consideration.

TABLE I.—SUMMARIES FOR THREE YEARS.

MONTHS.	RAINFALL.						NITROGEN.			AMMONIA.				NITRIC ACID.			
	1886–7.		*1887–8.*		*1888–9.*		*Grams per acre.*			*Parts per million.*		*Grams per acre.*		*Parts per million.*		*Grams per acre.*	
	No.	Inches.	No.	Inches.	No.	Inches.	1886–7.	1887–8.	1888–9.	1887–8.	1888–9.	1887–8.	1888–9.	1887–8.	1888–9.	1887–8.	1888–9.
March	7	2.00	3	.39	7	2.04	121.4	71.7	160.4	1.81	.76	71.6	158.5	1.45	.64	57.4	134.3
April	8	3.95	6	2.24	8	1.33	106.1	156.4	165.9	.70	1.18	161.1	160.8	.47	1.11	106.8	150.5
May	7	4.53	5	2.66	10	2.96	217.9	154.7	141.8	.46	.36	125.8	109.8	.84	.76	229.7	231.1
June	6	4.88	13	4.95	12	5.91	100.2	187.4	194.2	.27	.23	140.0	137.6	.64	.60	324.4	364.7
July	3	2.92	6	.35	7	4.02	187.4	37.8	122.8	.71	.23	25.3	94.7	2.13	.49	76.5	201.6
August	11	1.89	10	6.05	8	4.62	115.4	287.7	186.9	.37	.29	229.7	138.6	.72	.69	443.4	327.3
September	6	1.04	8	6.39	3	2.86	46.3	249.2	174.0	.34	.38	222.4	110.5	.45	1.28	297.3	373.4
October	3	2.18	2	2.13	5	2.74	84.2	52.2	177.3	.21	.62	44.7	174.3	.32	.54	69.2	151.6
November	1	1.08	2	.43	2	.48	65.5	117.7	60.0	2.67	1.19	117.5	58.2	1.71	1.12	75.5	54.4
December	4	1.43	5	.80	3	.98	50.8	71.0	129.7	.93	1.36	75.6	137.0	.48	.76	39.3	76.2
January	2	.18	3	.44	2	.73	20.1	33.4	43.6	.77	.66	34.7	49.2	.49	.19	21.9	14.1
February	3	.89	6	2.67	3	.31	107.4	119.5	70.2	.41	2.14	111.5	67.3	.46	2.11	124.8	66.4
Totals	61	26.97	69	29.50	70	28.98	1,222.7	1,538.7	1,626.8	.....	.....	1,359.9	1,396.5	.....	.....	1,866.2	2,145.6
Means	.....	.....	.....	.....	.....	.....	.....	.....	.....	.4498	.4703	.....	.....	.6173	.7226	.....	.....

TABLE II.—SHOWING PROPORTION OF AMMONIA AND NITRIC ACID IN SOME RAINS.

LITRES PER ACRE.	PARTS PER MILLION.	
	Ammonia.	*Nitric acid.*
850	14.50	4.84
10,075	4.30	7.04
1,750	12.60	8.33
3,500	9.10	2.56
7,975	9.10	2.71
9,750	4.35	3.30
3,900	6.10	2.82
925	2.85	3.95
28,200	.04	.51
312,730	.07	.31
121,900	.00	.38
112,500	.04	.64
206,250	.19	.38
26,925	.26	.16
10,750	.27	.25
62,250	.69	.13

ADDITIONS TO KANSAS BIRDS.

BY COL. N. S. GOSS, TOPEKA.

Frosted Poor-will, *Phalœnoptilus nuttalli nitidus.* A summer resident. Taken at Neosho Falls and Manhattan.

Little Brown Crane, *Grus canadensis.* This bird was omitted by oversight from the catalogues, and subsequent lists as reported to this society. It is not uncommon during migration.

OCTOBER, 1889.

ARTESIAN WELLS IN KANSAS, AND THE CAUSES OF THEIR FLOW.

BY ROBERT HAY, F.G.S.A., JUNCTION CITY.

[*Abstract.*]

This paper mentions twelve localities where there are artesian wells in Kansas. The Larned well has the largest flow—nearly three hundred gallons per minute—and gives out a strong brine. There is a group of wells in Hamilton county, and another group in Meade county, available for irrigation.

The principal feature in the paper is the discussion of the causes of artesian flow. The conditions resulting in the usual form of artesian wells, which are exemplified by those mentioned above, are a porous rock, having an out-crop to catch the rainfall of a region of some extent, and dipping toward the well with a layer of clay, clay-shale, or other impervious material, above and below it, so that the water of the porous stratum is inclosed as in a pipe, and it rises to the surface when the well-driller pierces the upper impervious stratum. The cause of the rising of the water in these conditions is *hydrostatic pressure*, just as it is in the rising of the water to the tops of high buildings in the water service of a city.

A well at Mound Valley, in Labette county, was described as illustrating the rise of water to the surface without the necessary hydrostatic pressure, the column of water being held up by an outflow of natural gas. This the writer termed *gas-pressure*, which in this case is an efficient cause of artesian flow, and which in other cases is probably a help.

Wells in Morton county and in Pottawatomie county were described, having

depths of three hundred to nine hundred feet, and having small but constant flow of mineralized water. In these wells the conditions of hydrostatic pressure appear to be absent, and in only one is there any show of gas; and for these and other wells the writer assigned a cause not usually found, for artesian flow. He called it *rock-pressure*, and said: "All rocks in the earth's crust contain some water. The more porous rocks contain the greater quantity. At a distance below the surface, the superincumbent mass subjects the rock masses to enormous pressure. If we assume that the rocks of Kansas to a depth of one thousand feet have an average specific gravity three times as great as that of water, we are probably within bounds, as, though limestones and sandstones are usually somewhat less, the presence of iron in many of the beds will bring up the average considerably. On this basis, a prism of the rocks to the depth of 600 feet and one inch square would weigh 781 pounds, which is equivalent to a pressure of 52 atmospheres. If then 25 feet be taken as the measure of a column of these mineralized waters equivalent to one atmosphere, the rock-pressure would be more than the equivalent of a column of water twice this height.

"Let a water-bearing stratum at a depth of 600 feet be pierced by the drill; we should then have the rock-pressure of 52 atmospheres squeezing the water out of the rock-pores, and, granting sufficient plasticity in the rock, and a sufficient quantity of water, it must rise in the tube, which has only the pressure of one atmosphere upon it. A large bore to the well and a small supply of water would be against its reaching the surface. On the other hand, a bed-rock with mobile molecules at or near saturation, under this enormous pressure, must cause in a narrow tube a flowing well. At 300 feet the rock-pressure would be only half that given above, or 26 atmospheres, and the column of water to be supported would be diminished in proportion. At other depths the same proportions will hold good.

"Here, then, we have a force that may be an aid to an artesian flow, which is mainly due to the usual causes of such flow, and which is a most efficient cause for the constant flow of wells whose depth is great, and whose quantity of water is small. We are inclined to consider rock-pressure as the cause of the flow of the Pottawatomie and Morton county wells—at least till future search shall make it more probable that it is due to the usual causes of artesian wells."

SOME KANSAS MINERAL WATERS.

BY PROF. E. H. S. BAILEY, STATE UNIVERSITY.

Although this is a comparatively new State, its resources have been wonderfully developed within the past ten years. In common with other possible sources of wealth, the mineral waters have received much attention. Some of them flow from springs, while others are obtained from wells both shallow and artesian. In order that a permanent record may be made of the analysis of some of these waters, the author has selected some of the more important ones, that have been examined in the laboratory of the State University, and presents the analyses for publication.

MARION MINERAL WELLS.

These wells, or more properly this well, is situated in the northern part of Marion, about fifty feet from a small creek. The well, which was drilled as a prospect well, is 175 feet deep, and has two pumps; the first takes the water from a depth of 50 feet, at a point just above the rock, and the other takes the water from a point 25 feet above the bottom. Both contain some hydrogen sulphide gas when first drawn. The temperature is 57° F. The waters are utilized, the upper for drinking and the

lower for bathing purposes. The analysis shows the upper vein to be a saline water, and the lower a strong brine, much stronger than sea-water.

Upper Vein.

Upon analysis the water is shown to contain the following substances, the result being expressed in grams per liter:

Calcium oxide	.5841
Magnesium oxide	.3783
Sodium oxide	.6064
Ferric oxide	.0056
Sulphuric anhydride	1.3736
Carbonic anhydride (calculated)	.2924
Chlorine	.5780
Silica	.0216
Organic matter	Trace

These constituents are probably combined as follows, expressing the results in grains per U. S. gallon of 231 cubic inches:

Sodium chloride	55.548
Magnesium sulphate	65.310
Sodium sulphate	13.594
Calcium sulphate	48.736
Calcium bicarbonate	32.052
Iron bicarbonate	0.723
Silica	1.261
Sodium hydrosulphate	Trace
Organic matter	Trace
Total solids	217.224

Lower Vein.

Upon analysis the water is shown to contain the following constituents, the result being estimated in grams per liter:

Calcium oxide	1.3858
Magnesium oxide	.7772
Sodium oxide	30.2090
Ferric oxide	.0044
Sulphuric anhydride	6.9944
Chlorine	33.1232
Silica	.0128
Carbonic anhydride	Trace
Organic matter	Trace

These constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Sodium chloride	3183.230
Sodium sulphate	358.230
Calcium sulphate	196.228
Magnesium sulphate	135.974
Iron bicarbonate	.010
Silica	.013
Organic matter	Trace
Total solids	3873.685

CHINGAWASSA SPRINGS.

These springs are situated about three miles north of Marion, Marion county. Within a radius of a quarter of a mile there are at least 50 springs. Most of these, however, are ordinary fresh-water springs. There are three or four that are strongly impregnated with mineral matter. The analysis of one of these is given, as it is a representative of the class. This is the so-called "North spring." A 1½-inch stream is constantly running from it. The temperature is 57.2° F. On the bottom and sides

of the spring may be seen a white deposit of sulphur, and the odor of hydrogen sulphide is quite perceptible.

Upon analysis the water is shown to contain the following constituents, the results being estimated in grams per liter:

Calcium oxide	.8422
Magnesium oxide	.1308
Sodium oxide	.0505
Potassium oxide	.0048
Ferric oxide	.0010
Silica	.0162
Sulphuric anhydride	1.2704
Carbonic anhydride (calculated)	.1432
Chlorine	.0280
Hydrogen sulphide	

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Potassium sulphate	0.490
Sodium chloride	2.688
Sodium sulphate	3.138
Magnesium sulphate	22.884
Calcium sulphate	97.391
Calcium bicarbonate	24.867
Iron bicarbonate	0.175
Silica	0.945
Sodium bicarbonate	Trace
Sodium hydrosulphate	Trace
Total solids	152.578

Free carbonic acid gas.
Free hydrogen sulphide gas.

PARSONS MINERAL WELL.

This water comes from a well about 30 feet in depth, situated upon a farm on the open prairie. It is remarkable in the large amount of nitrates contained, and the abundance of magnesium salts.

Upon analysis, the water is shown to contain the following ingredients, estimated in grams per liter:

Calcium oxide	.6914
Magnesium oxide	1.3528
Sodium oxide	.4454
Potassium oxide	.0074
Ferric oxide	.0008
Silica	.0146
Sulphuric anhydride	3.6742
Chlorine	.1414
Nitric anhydride	.0162
Organic matter	Trace
Carbonic anhydride (calculated)	.5173

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Potassium sulphate	.804
Sodium nitrate	1.487
Sodium chloride	13.590
Sodium sulphate	43.360
Magnesium sulphate	236.680
Calcium sulphate	52.950
Calcium bicarbonate	55.380
Sodium bicarbonate	Trace
Iron bicarbonate	.134
Silica	.851
Organic matter	Trace
Total solids	405.236

CARBONDALE SPRING.

This is situated about two miles north of the city, on the Topeka road. The temperature is 54° F. The water is quite abundant. This water contains a comparatively large quantity of free ammonia, and little albuminoid ammonia. From a knowledge of the situation of the spring, it would not seem possible that the ammonia could come from any surface contamination, and it is probably a natural constituent of the water.

Upon analysis the water is shown to contain the following ingredients, estimated in grams per liter:

Calcium oxide	.1121
Magnesium oxide	.0443
Sodium oxide	.9742
Potassium oxide	.0097
Ferric oxide	.0004
Alumina	.0001
Silica	.0051
Sulphuric anhydride	.3707
Phosphoric anhydride	.0001
Boric anhydride	.0097
Chlorine	.7946
Bromine	.0009
Iodine	.0001
Carbonic anhydride (calculated)	.2630
Ammonia	.0025

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches.

Sodium chloride	76.361
Sodium sulphate	35.817
Calcium bicarbonate	16.959
Magnesium bicarbonate	9.430
Calcium sulphate	1.639
Potassium sulphate	1.044
Sodium bicarbonate	.910
Sodium biborate	.752
Sodium bromide	.070
Sodium iodide	.003
Alumina	.560
Silica	.297
Iron bicarbonate	.069
Sodium phosphate	.006
Ammonia sulphate	Trace
Total solids	143.917

EUREKA MINERAL WELL.

This water comes from a well something over one hundred feet in depth. From the analysis it will be seen that besides the ordinary constituents it contains bromides, iodides, phosphates, and borates.

Upon analysis the water is shown to contain the following ingredients, estimated in grams per liter:

Calcium oxide	.3626
Magnesium oxide	.1835
Sodium oxide	3.6369
Potassium oxide	.0833
Ferric oxide	.0012
Alumina	.0017
Sulphuric anhydride	.4834
Chlorine	4.3919
Phosphoric anhydride	.0003

Silica	.0137
Bromine	.0004
Iodine	.0001
Boric anhydride	Trace
Nitric anhydride	Trace
Organic matter	Trace
Carbonic anhydride (calculated)	.2178

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Sodium chloride	400.250
Magnesium chloride	18.119
Potassium sulphate	7.417
Calcium sulphate	42.135
Magnesium bicarbonate	11.220
Calcium bicarbonate	10.980
Iron bicarbonate	.204
Sodium bicarbonate	Trace
Sodium nitrate	Trace
Sodium bromide	.026
Sodium iodide	.006
Sodium phosphate	.034
Alumina	.099
Silica	.799
Organic matter	Trace
Total solids	491.289

In conclusion, I wish to acknowledge the able assistance afforded me by Mr. E. C. Franklin, who has performed a large portion of the analytical work on the above waters.

NOTES ON THREE SPECIES OF GOPHERS FOUND AT LAWRENCE, KAS.

BY PROF. L. L. DYCHE,* STATE UNIVERSITY.

I. Ground Squirrel (*Spermophilus tridecemlineatus*). Rather common. It digs up corn, squash, melon and other seeds soon after they are planted. Farmers say that these ground squirrels can smell the seeds in the ground, for they always dig straight down to them. Some watermelon farmers report that the squirrels frequently stop the growth of a vine by nibbling or cutting off the tender runner near the end. Some cases have been reported where they cut holes in the nearly ripe musk- and watermelons and ate the seeds out.

II. Ground Squirrel (*Spermophilus Franklini*). At present not common, except in certain localities in the eastern half of the State. Not much damage done by this species — at least not much thus far reported, except from certain localities, and most of these where fields were inclosed by stone walls or hedges, which gave the squirrels special protection. The squirrels dig up the corn, and sometimes other seeds, soon after it is planted, in the spring. In the fall they do some damage by burrowing under corn-shocks; they eat some of the corn, and usually carry considerable down into their burrows. They were very common on my father's farm, (at Auburn, Shawnee county, Kas.,) about fifteen years ago.† They would dig up the corn almost as fast as it was planted for a distance of from fifteen to fifty yards all along the stone walls wherever the latter inclosed the fields. On an average, there could not have been less than one squirrel for each rod of fence; apparently there

*Read by title at the Leavenworth meeting, Nov. 1, 1888.

†Information from various sources goes to show that this species of squirrel-gopher was very common in many regions of the eastern third of the State about fifteen years ago.

was one for each few feet. We killed many of them with guns, and tried to poison them, but with apparently very little success.

By scattering shelled corn along the fences for the squirrels to feed upon while the planted corn was coming up, most of the difficulty was obviated. A wary old female cat which had taken up her quarters in a barn in one of the fields caught many of these squirrels, and was accustomed to carry them to her kittens. The offspring of this cat, when full-grown, also preyed upon the squirrels. In the course of a few years these cats, over a dozen in number, almost, if not entirely, exterminated the squirrels on our farm and neighboring territory. The cats would conceal themselves in the grass and weeds along the walls, or more commonly crouch upon the top of the walls, and pounce upon the squirrels when out from their hiding-places. These same cats also caught many rabbits after the squirrel supply began to diminish. I do not know of any other instance where cats caught the large ground squirrels to any considerable extent.* These cats also caught pocket gophers and the little striped ground-squirrel gophers.

III. Pocket gopher (*Geomys bursarius*). Common everywhere throughout this section of the country. There must be as many as one per acre, or even more, in certain favored localities. Nurserymen and gardeners have the most complaints to make against this "very troublesome little animal," as it is frequently termed; the principal of which may be summed up in the following manner: They do considerable damage to young hedge-rows by burrowing under them and cutting off the roots and underground stems. As a rule, the damaged places are but a few feet in length, but some instances have been noted where a third, or even a half, of the plants have been destroyed for a distance of a hundred feet or more. This usually happens where the gopher's course crosses and recrosses the hedge-row. Other kinds of trees are sometimes killed in a like manner in nurseries, and a few in young orchards. Potato farmers, particularly those raising sweet potatoes, complain that the gophers work on their crops from the time they are planted until they are removed from the fields. In some sweet-potato fields which I visited, places were found in the rows from a few feet to two or three rods in length where the gophers had either killed the vines while they were quite young, or had cut up and carried away most of the potatoes after the latter were formed.

Winter before last Mr. Gibson, a farmer who lives one and a half miles north of Lawrence, lost thirty-five bushels of sweet potatoes by gophers. They were removed from a cellar which contained five hundred bushels. The cellar was dug in sandy soil in the edge of the field where the potatoes were raised. The gophers effected an entrance at the bottom of the cellar, under the edge of the boards which lined one of its sides. The cavity from which the potatoes were removed was four feet deep on the side where the gophers entered, and extended for some considerable distance into the interior. The hole from which the potatoes had been removed was packed solid with earth. This hole was undoubtedly filled up with earth as fast as the potatoes were removed; for there was no external evidence, by settling of the potatoes in the bin, of the mischief which was going on underneath. After the potatoes were removed in the early spring, traps were set, and two gophers (apparently all which had been working upon the potatoes) were caught.

Several reports have been noted to the effect that from one to fifteen bushels of Irish potatoes have been removed by gophers from potato-heaps buried in fields. Some damage is reported to have been done to cabbage and various other garden plants by eating off roots and stems, and then usually pulling the plant down into the ground.

* Prof. G. H. Failyer, of the State Agricultural College, reports a similar case as having come under his observation in southeastern Iowa.

Gopher-hills in meadows are considered a great nuisance by those who run mowers, but no complaints have been made of their injuring the meadows other than that a little grass or grain is covered up. On the other hand, it is claimed by some that much good is done in old fields by gophers, as they bring up the rich subsoil.

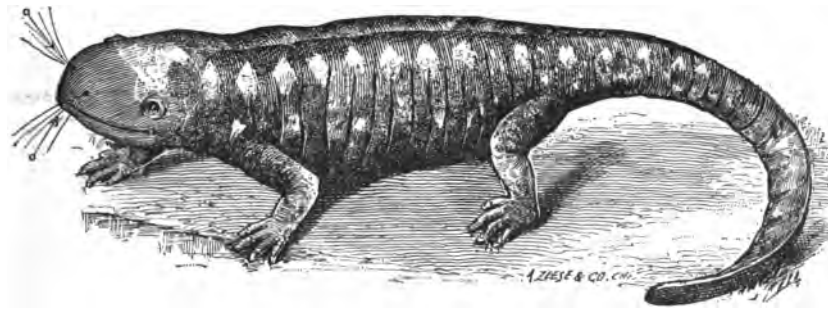
Rev. A. Clark, who lives one-half mile east of Nickerson, reports that gophers were very thick on his farm. They killed a large number of apple and cherry trees. Many of the trees were four and five years old, three inches or more in diameter, and ten feet high. One acre of hedge plants was entirely destroyed. As many as twelve gophers were seen at work at one time on less than a half-acre of hedge plants. He finally succeeded in freeing himself of the gophers by using strychnine in potatoes. He dug down and dropped poisoned potatoes in the gopher-burrows. Potatoes should be used about the size of quail's eggs or hulled walnuts; otherwise the gophers throw them out with the dirt without noticing them. The theory, as reported, is, that if the potato is too small the gopher carrries it out in his pocket or pushes it out with the loose dirt; but if the potato is larger, he will take it in his mouth to remove it, and thus discover the juicy and luscious bait.

THE MODE OF RESPIRATION OF THE COMMON SALAMANDER.

(*Amblystoma mavortium.*)

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

In November, 1888, Mrs. F. W. Apitz presented to my biological laboratory a living specimen of the common yellow-spotted salamander (*Amblystoma mavortium*). It was kept on my table in a glass jar, and during the following winter and spring afforded an interesting subject for investigation. My attention was soon attracted to the fact that although in the final air-breathing stage of development, with fully-formed lungs and entirely deprived of external gills, this animal passed a large portion of the time in the bottom of the jar, coming to the surface of the water at



intervals of about five minutes, *apparently* for the purpose of taking in air. Subsequent examination indicated that this coming to the surface was *really* for the purpose of ejecting inspired air abstracted from the water. Not understanding how a single gulp of air could suffice for aëration for periods of such long duration, I observed more closely, and soon detected a current of water continuously entering each nostril. This double current of inward-moving water was made evident by the solid impurities of the water, which had become roiled. These were being constantly drawn into the mouth through the nostrils, with the water. I had also noticed that the salamander opened its mouth at intervals of from seven to eight seconds, and at first supposed that this indicated that the animal was becoming

oppressed for lack of air, and was therefore gasping for breath. As soon as I discovered the inward currents through the nostrils, I also detected an outward, rather than an inward, flow at each opening of the mouth. Further observation disclosed the enlargement of the throat as the mouth filled with water from the nostrils, the mouth opening to release the water, and the swelling of the throat subsiding as the mouth was closed. This operation was carried on for hours at a time, when the salamander would rise to the surface of the water, and, keeping its mouth shut, would for perhaps an equally long period breathe air directly into the lungs in the same manner as a frog. I had this specimen under my constant observation for nearly six months, and frequently called the attention of my students to its peculiar mode of respiration. I also had a second individual of this species in my laboratory in July, 1889, and found the operation repeated in every particular. An examination of the interior of the mouth of these salamanders revealed the presence of numerous ridges or folds of the mucous membrane in the palatal region, suggesting a probable respiratory function analogous to that of the gills of the same animals in the larval stage. The accompanying figure, from a drawing by my assistant, Mr. W. C. Stevens, represents the salamander reduced to two-thirds of its natural size.

CHARACTERISTIC SAND-HILL FLORA.

BY PROF. M. A. CARLTON, GARFIELD UNIVERSITY.

All along the principal river valleys of Kansas, especially over the broad valley of the Arkansas, numerous hillocks of sand are to be seen, which usually possess a very scanty vegetation. Many of these hills are at great distances from the present river-beds; the waters having long ago left them and receded to the present river-level. In such cases the flora is somewhat more abundant; but in all cases, wherever these hills may be found, so far as the writer's experience goes, the flora is in the main composed of the same species, although in some cases there may be a greater abundance of these species than in any others; and, indeed, a few forms may sometimes be added that are purely local.

I was first led to note these facts during the summer of 1888. In May of that year I made some collections in the vicinity of Wichita, among which were a species of plum (*Prunus chicasa*, Mx.), sometimes called the sand-plum, and the brilliant orange-flowered puccoon (*Lithospermum hirtum*, Lehm). The latter was found in a single locality on a sandy waste. Previous to this I had collected, on rocky points in Cloud county, a few specimens of a plum in flower which I did not recognize, not having yet seen the fruit. On returning to Cloud county and collecting the fruit, it proved to be the same *Prunus chicasa*. Then I remembered having seen the same species on various sand-hills along the Smoky Hill river in Saline county, and afterward I found it again in various places in Cloud county, but always in sandy wastes or on rocky points. Later on, while collecting near Miltonvale, Cloud county, I found, growing on a sand-hill, along with the previously mentioned plum, a number of fine specimens of *Lithospermum hirtum*. But, to my knowledge, this species does not grow on any other spot in that county, and I have made a pretty clean survey of the county.

These discoveries induced me to make further observations, the results of which are embodied briefly in this article. I simply present an account of each of the few species that have so far come under my consideration, in the order of their abundance and predominance as characteristic sand-hill species. Of course this is all, at most, only preliminary to further investigations on the same subject. I simply give

a few facts at present. Any additions to these facts, or any definite conclusions of value that may be drawn from the facts, must be left for future papers. An intimation here of what I have further in mind in regard to this subject might however not be amiss. The idea has naturally enough suggested itself that these species may possibly bear to each other a somewhat similar relation in regard to structure, composition, and vitality, to that which they bear in regard to habitat. This is one of the questions, then, among those that may be found worthy of careful consideration. I am indebted to Prof. J. M. Coulter of Indiana and Prof. W. A. Kellerman of the Kansas Agricultural College, for aid in identifying some of the species.

SPECIES OBSERVED.

Prunus chicasa, Mx.—This is the most common sand-hill species. I have never noted its absence on any sand-hill of ordinary extent, and it sometimes grows where it seems nothing else can grow. It is found on some of the most recently formed hills, near to rivers, as well as on the older hills. Very common over a great portion of Sedgwick county, which is to a great extent bottom land, and therefore sandy. In a few places only in Cloud and Saline counties, and always on sandy wastes or rocky points.

Lithospermum hirtum, Lehm.—I have never observed this species, I think, outside of sandy districts, although I presume it has a more general distribution. Have observed and collected it in several places in Sedgwick county, and in one spot only in Cloud county.

Evolvulus argenteus, Ph.—Have collected very few specimens of this species; chiefly in Cloud county, on sandy wastes. It is reported from extreme southwest Kansas, where the country is quite sandy and somewhat barren.

Yucca angustifolia, Ph.—This species, while quite common, I think is not often found in low, moist or rich soils. I have almost invariably found it on sandy wastes, rocky hillsides, or in barren districts; and I have observed its habitat from Kansas to Montana. It is very abundant in western Kansas and eastern Colorado, which we all know to be quite a barren region. It is reported to be very abundant on the "Staked Plains" of Texas, growing, it is said, to the height of ten feet—probably a different species. The yucca soap manufacturers, of Wichita, obtain their material from the Texas yucca. In Riley county I have collected it invariably on rocky hillsides. On the extreme western plains it is associated with the sage-brush, prickly-pear, and buffalo-grass, while in the Rocky Mountains it frequents dizzy heights among the rocks just below the timber-line. It occurs along with cacti in abundance all over the southern portion of the Great Basin, and on into Mexico. All of this region is extremely barren.

Discopleura capillacea, DC.—While not limited strictly to sand-hills, this species seems to be at least characteristic of sandy districts. Have collected it on sandy wastes, in Cloud county, and in various places in Sedgwick county.

Viola tricolor, L.; *var. arvensis*, DC.—This species is extremely abundant all over the more sandy portions of Sedgwick county. Of course it is not at all limited to sandy regions, but seems only to be well adapted to such localities, and to some extent characteristic of them. It is often associated with *Prunus chicasa*, and is found on the outskirts of low woodlands and along roadsides and rising ground.

Cristatella Jamesii, Torr.—I have collected this species at Concordia, Cloud county, on sandy knolls near the Republican river, and have found it in abundance in the vicinity of Wichita, also, but always in sandy soils.

Linaria Canadensis, Spreng.—Have collected very few specimens of this species; always in sandy wastes. According to Gray's Manual, it is common in sandy soils·

I think this species has not heretofore been reported from Kansas, although it is a common species farther east. So far I have only found it in Sedgwick county.

Aplopappus divaricatus, Gr.—This species is very abundant in sandy regions, in the vicinity of Wichita, and, according to Smyth's "Catalogue of Flowering Plants and Ferns of Kansas," it is found in Barton county, a great portion of which is included in the sandy valley of the Arkansas. It is my intention to study this species still further.

Frœlichia gracilis, Moq.—The habitat of this species needs to be studied more carefully. I have collected only a few specimens, in sandy wastes near Wichita. Reported also from Cherokee, Barton and Dickinson counties. (Smyth, "Catalogue of Flowering Plants and Ferns of Kansas.")

Hosackia Purshiana, Benth.—This species seems to be characteristic of sandy districts, although quite common in other places, especially in western Kansas. Have collected it in Cloud and Sedgwick counties. It is also reported from Pawnee, Barton and Dickinson counties. (Smyth.)

The following species may yet be added to this list, also, after a better knowledge of them in regard to habitat is obtained:

Pentstemon acuminatus, Dougl.; Pyrrhopappus scaposus, DC.; Cyperus acuminatus, Torr.; Flaveria angustifolia, Pers.; Camelina sp.; Gramineæ, several species.

EXPERIMENTS FOR THE ARTIFICIAL DISSEMINATION OF A CONTAGIOUS DISEASE AMONG CHINCH-BUGS.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

At the last annual meeting of the State Board of Agriculture I presented a paper concerning the diseases of the chinch-bug. Three of these diseases were considered, and one of them was stated to have made its appearance in portions of eastern and southern Kansas in 1888. Attention was called to the investigations of Professor S. A. Forbes, the Illinois State Entomologist, and to the experiments of Dr. Otto Lugger, of the Minnesota Agricultural Experiment Station. So late as May, 1889, Professor Forbes looked upon the artificial introduction of these diseases as having no more than a theoretical basis, and Dr. Lugger in the report of his own experiments, expressed a doubt whether the fungus disease whose germs he distributed to different localities in Minnesota in 1888, did not after all reach these localities in the natural way. Being anxious if possible to settle this question and to place in the hands of our farmers a new and more efficient weapon in their warfare against their most formidable insect foe, I sought earnestly in the spring and early summer of 1889 for the first indication of the appearance of either of the three chinch-bug maladies. In these investigations I have been heartily sustained by Secretary Mohler, who has furnished all possible aid in the accomplishment of the results finally attained. The last week in June I received a letter from Dr. J. T. Curtiss, of Dwight, Morris county, conveying the gratifying intelligence that a disease had broken out among the chinch-bugs, and that the ground in many places in fields of oats and wheat was white with the dead bugs. Dr. Curtiss stated that on June 22d he saw the first sick bugs, and in a few days dead ones. From this date to June 30th, the disease destroyed the bugs in most of the fields. Where the oats or wheat were heavy, shading the ground thoroughly, *all* the bugs died. Where the crop was thin on the ground, many bugs escaped the disease. The Doctor was at once requested to forward samples of the sick and dead

bugs for examination and experiment. He did so, and the disease proved to be one of the three to which your attention was called in my paper at the last annual meeting of this Board. I have termed this disease the "White Fungus disease," the scientific names of the little plant which produces it being *Entomophthora* and *Empusa*. This disease has for several years been known to attack the chinch-bugs, and is probably identical with the malady which first attracted the attention of Dr. Shimer in Illinois as long ago as 1866. In favorable seasons this disease often spreads in a natural way from field to field and county to county, over a considerable extent of territory, sometimes including an entire State, and even two or three adjacent States. But up to the summer of 1889 no successful method had been devised for the artificial communication of the disease from an infected district to an uninfected district. Professor Forbes had conducted culture experiments with this fungus without success, with the intention of distributing the germs of the disease, apart from the bugs themselves. This method has great promise of success in the future, but success has not yet been realized.

On receipt of the sick and dead chinch-bugs from Dr. Curtiss, I at once imprisoned a large number of healthy Douglas county bugs with the infected material, and in a few days the disease was communicated to the fresh subjects, and it was clearly established that the disease could be successfully propagated in the laboratory. During the whole course of my experiments I have found that apparently the disease is more readily communicated from the still living sick bugs than from the dead ones. Just at this time an unexpected opportunity was presented for testing this question by an experiment conducted upon a larger scale than had previously been possible. This opportunity was afforded through the enterprise of a reporter for the Lawrence *Daily Tribune*, who appeared on the scene at the right moment, and published a brief account of the appearance of a contagious disease among the chinch-bugs of Douglas county, and stated positively that the disease could be started in any field and the field soon cleared of bugs by scattering a few dead bugs, which could be obtained by sending an application to the writer of this article. In a few days I began to receive a large number of letters from no less than nine different States, begging for "diseased and deceased bugs." The magnificent opportunity thus afforded by the rather too "previous" reporter was not allowed to go unimproved, and during July and August sick and dead bugs were sent to farmers and Agricultural Experiment Stations in Kansas, Nebraska, Iowa, Missouri, Minnesota, Michigan, Indiana, Illinois, and Kentucky. The following letter of instructions accompanied each package of bugs:

DEAR SIR: Having just obtained a limited supply of diseased chinch-bugs, I inclose a small box of them for your use, on condition of your making a careful trial of them and reporting to me the result.

Please observe the following directions: Mix these bugs with ten or twenty times as many healthy bugs, and keep them together for 36 or 48 hours. Then turn them loose (both dead and living ones) on the field selected for the experiment. Watch closely for the result. A similar lot sent to Ottawa county, Kansas, two weeks ago and distributed according to the above directions, soon communicated the disease to that region. The bugs began to die in five days after the infected material had been "planted."

Please make a careful record of your proceedings, and *report to me*, as I am very anxious to discover the best possible method of spreading this disease among our farmers' most destructive enemies.

Yours truly, F. H. SNOW.

The results of this wholesale experiment have been exceedingly satisfactory, and are best presented by the following selections from an extensive correspondence:

H. J. Waters, assistant agriculturist of the Missouri Agricultural Experiment Station at Columbia, wrote July 10th: "On the station grounds here the chinch-bugs are very numerous, and are increasing with alarming rapidity. I have kept close watch for the natural appearance of the disease, but so far no bugs have shown any

signs of it. Would it be possible for you to send us a number of these insects that have died of the disease, to be used in infecting our experiment plats, and enable us to study the experiment?"

The infected material was sent out on July 18th, and on the 30th the following report was received from Mr. Waters: "Chinch-bugs have died rapidly during the last two days. Most of the dead ones are on the grass and weeds; comparatively few die on the ground. Those dying on the ground, under the shade of weeds and grass, develop a larger growth of mould than those found on the upper blades of grass. So far the disease appears to be specially fatal only in or near the localities infected July 21st, yet dead bugs covered with the mould are found in considerable numbers several rods away from the spots first infected." Four days later the following was received from the same source: "I desire to say further, that in the field first infected it is very hard to find a live chinch-bug. Two weeks ago they were there by the million. Many dead ones can be seen."

The following report was made by Professor F. M. Webster, entomologist of the Indiana Agricultural Experiment Station, and for many years one of Professor Riley's most trustworthy field-agents: "The germs of *Entomophthora* received July 20th have had the effect of destroying enough chinch-bugs to warrant the statement that they communicated the disease and established it in the field. What the ultimate result will be, and whether it will be of service to the farmer in dry weather when he most needs it, are questions yet to be settled."

The following is from a Clearwater, Minnesota, farmer, to whom infected material was sent August 5th: "Every marked hill of corn was freed of bugs before the corn was cut (1st to 15th of September), but still there were some bugs in the field, but nothing in comparison to what it was when the fungoid bugs were planted, and *they* seem to be semi-paralyzed. So firm is my belief in the efficiency of this method that I have saved about 1,000 infected bugs for next year. Please accept my thanks for the bugs, and I will hoist my cap for white fungus.—THAD. J. WOODWORTH."

The county treasurer of Worth county, Iowa, wrote as follows, September 2d: "The dead chinch-bugs you sent me did good work. I did as you directed, and in about eight days after I put them in my fifty-acre corn field the bugs began to die, and now about two-thirds of them are dead. I will now take pains to get them scattered over the county.—G. N. HAUGEN, Northwood, Iowa.

"P. S.—The weather has been very dry since I commenced the experiment, July 22d; only one shower of rain in six weeks."

The following two letters are samples of many communications from Kansas farmers:

"NAVARRE, DICKINSON CO., August 7.

"I received your deceased chinch-bugs now nearly three weeks ago. I followed the inclosed directions, only I mixed perhaps ninety or one hundred times as many as you sent. I put them in a tin quart can and left them in there for about forty-eight hours. Three days afterward I went out and looked, and to my surprise found some dead ones. I went out a week afterward and found half of them dead. I passed the other day again and could scarcely find any that had life in them, and what few there were, were sick, so that they could hardly move. I certainly feel very grateful to you for your kindness in sending me these few bugs, and I believe it will be a blessing to the country.

J. H. LENHART."

"LARNED, Aug. 1, 1889.

"DEAR SIR: Your letter of the 18th ult. with the small box of chinch-bugs came to me safely. Your directions in my experiments with the bugs were carefully followed. After the diseased ones had been with the healthy ones for forty-two hours I took them to my farm, expecting to plant them, but found I had been anticipated in the work of destruction by heavy rains. I then brought them back and put them on the farm of Capt. A. C. Morris, just south of town, where there were bugs. They seemed to perform the work whereunto they were sent, the bugs in the portion of the field infected being killed so far as I could observe. Of one thing I am well satisfied, and that is that the disease is communicable, just to what extent my experiments have not been of a character to establish.

Yours truly, SAMUEL HOUSTON."

These experiments for the artificial extension of the white-fungus disease having been thus successful, I am anxious to keep the germs of the disease alive in my laboratory continuously, so that I may be able to continue the experiment during the coming season. In order that the vitality of these germs may be more certainly preserved, I desire to obtain constant supplies of live chinch-bugs for the purpose of communicating the disease to fresh material during the winter and spring. I therefore respectfully request those interested in these experiments to furnish the desired material. It is a difficult matter to find any live bugs in Douglas county, and the farmers of the State will without doubt willingly coöperate with the writer in continuing an investigation which promises to secure to them results of great practical value.

WHO SOLD HIS WHEAT FOR $1.40?—OR AN EXAMINATION OF THE VALUE OF BLAKE'S TABLES.

BY GEO. E. CURTIS,* WASHINGTON, D. C.

In the fall of 1888 a copy of *Blake's Tables of Weather Predictions for 1889*† fell into my hands, and I was so much interested in the pamphlet in view of the considerable attention that it was receiving, that I began a review of its contents. But engagement in other duties interfered with the completion of this review, and my further attention was diverted from the subject until I recently read in the *Kansas Farmer* that "Prof. Blake is having an extensive sale for his Annual of Weather Predictions for 1890." The present time, therefore, seems to be especially opportune for making an impartial examination of the "Tables" for 1889. For, if Mr. Blake's long-range predictions have been strikingly fulfilled, the fact would furnish some ground for purchasing his "Tables" for 1890, and for following his advice as to early or late planting, the character of crop to put in, and the time to sell grain. But if, on the other hand, his most important and most confidently emphasized predictions have entirely failed, assuredly Kansas farmers will wish to know this in order to escape following blind leaders of the blind. Manifestly, therefore, the most rational thing to do is to make such an examination of the "Tables" as will enable us to determine their claim to our attention. In common with all professional meteorologists with whom I am acquainted, I am ready to welcome any more powerful methods of weather prediction than are now known to the scientific world; but for some reason Mr. Blake has not seen fit to publish the detailed methods that he has employed in calculating his "Tables," and he has given only vague references to "four large account books filled with formulas and figures," and to the discovery of a mysterious "universal law of axial rotation," which has been the "stepping-stone" to his success.

If these discoveries are genuine astronomical or physical laws, then the highest honors would follow their publication, and hence the present secresy justly but unfortunately throws upon them a suspicion which they ought not to predeserve. In lieu, therefore, of studying the methods by which the "Tables" were constructed, there remains only to determine their success, by comparing the predicted with the actual weather; and it is to such a comparison that I invite all who are yet uncertain as to whether in the present state of knowledge they do well to trust in any long-range predictions.

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*Lately Professor of Mathematics, Washburn College, Topeka, Kansas.

†Blake's Tables of Weather Predictions for each State for each month of 1889, according to mathematical calculations based on astronomical laws: C. C. Blake, Topeka, Kansas.

The "Tables" consist primarily in tabulated temperatures and monthly rainfalls predicted for each State. But in addition to these, and by their aid, Mr. Blake has in a running commentary interpreted the figures, and with more or less definiteness described what would be the main characteristics of the different seasons. Such of these predictions as are expressed unconditionally are here given:

1. "In January, 1889, there will be considerable steady cold weather, with a good deal of snow, which will drift badly, probably causing numerous railroad blockades; the mean temperature will be a trifle *below* normal."

2. "The precipitation is to be large in January in most of the country, and much heavier than usual in the Northwestern States."

3. "On the Pacific coast the rains will continue much later in the spring than usual."

4. "In the western third of the State [Kansas] we think all crops should be planted as soon as the cold snap is over in April. There will be no more cold weather after that severe spell in April." Minimum temperature in April in eastern half of Kansas will be 17°, mean temperature will be 50°, five degrees below the average.

5. "We calculate that the summer will be a hot one in the Northern States. . . . The temperature will be very hot in July and August in most every part of the country."

6. "We are quite confident that there will be no hot winds in Kansas before the middle of August."

7. "The unprecedented drouth of 1889." "Such a drouth as that of next summer will search out every nook and corner, scarcely leaving any green thing in large parts of the country."

"As will be seen by an inspection of the Tables, such will be the fate of most of the Northern States next summer."

"We gave ample warning of the drouths of 1886 and 1887, and now give warning of the still greater drouth of 1889."

"In Ohio and Michigan . . . the drouth will start in April and continue without a break till the crop season is virtually over."

NEW ENGLAND AND MIDDLE ATLANTIC STATES: "In these States the drouth will generally commence in June and be very severe in August and September."

"In the Eastern States, as a rule, the drouth will be very severe."

"Would that we were able to avert the horrors of the eastern, western and northern sheol of 1889."

8. "There will be very heavy rains in the Ohio valley in August and September, amounting to floods in some places. . . . It will be too late then to make a crop."

9. "There will be enough rain in a large part of Kansas to raise an immense crop of corn if it is well put in on time, and thoroughly tended. In most of Kansas it will be very favorable for potatoes, as well as most other crops."

10. "East of the Rocky Mountains it will generally be too dry for that crop [potatoes] in the Northern States, and in part of the Southern States it will be too wet."

11. "Next year there will be frosts in September, but none in August in the spring-wheat regions."

12. "When wheat was selling for 80 cents at Chicago last summer, and we advised our readers to sow a large crop of wheat in Kansas, telling them that it would be worth $1.40 at Chicago next July, we were thought by some to be wild. But when our readers inspect all the weather tables herein, they will not think our table of prices is so very wild as it seems to be."

TABLE OF PRICES OF NO. 2 SPRING WHEAT FOR 1889.

Date.	Predicted by Blake.	Actual market.
January 31, 1889	$1 34	$0 94½@$0 95½
February 28, 1889	1 52	1 03½@ 1 04½
March 30, 1889	1 50	1 00 @ 1 01
April 30, 1889	1 85	81 @ 82
May 31, 1889	1 87	77½@ 78
June 29, 1889	2 30	81 @ 82
July 31, 1889	1 72	78 @.....
August 31, 1889	1 74	77 @ 77½

13. "The northern corn crop will mostly be a failure, and prices will be high a year from now."

14. "As will be seen by the table, the west third of Kansas will be deficient in rain after June."

The preceding extracts comprise the principal predictions made by Mr. Blake as deductions from his "Tables." And because a comparison of all his tables with the actual temperatures and pressures would be too great a labor, and since any selection by me of a portion of them might not fairly represent the whole, it seems best to confine the verification to Mr. Blake's own selection from the tables and his predictions based thereon.

The data used in the work have been obtained from the United States Bureau of Statistics, the Department of Agriculture, the Reports of the State Weather Services, and the Weekly Crop Bulletin and Monthly Weather Review of the Signal Service; and I am under obligation to the officers of these various Bureaus for their kind assistance in furnishing me the necessary material.

ACTUAL WEATHER.

1. "As a whole the snow-falls of January, 1889, have been *unusually small.*" "The mean temperature was generally *above* the normal over all districts east of the Rocky Mountain regions, except in portions of Florida and Texas."—*Monthly Weather Review.*

In Dakota and Minnesota, where the predicted "steady cold weather" would naturally be expected to occur, the mean temperature was from 10° to 15° above the normal.

2. To test the value of the special prediction of heavy precipitation in the Northwestern States, the following table has been prepared, giving Mr. Blake's predicted precipitation, the normal precipitation for January, and the actual precipitation.

PRECIPITATION IN NORTHWESTERN STATES.

Location.	January normal. (Given by Blake.)	Predicted amount for January, 1889.	Actual amount for January, 1889.
Wisconsin	1.65	4.52	2.30
Iowa	1.05	4.97	Normal.
South Minnesota	0.87	3.28	1.00
North Minnesota	0.70	2.67	
East Dakota	0.40	2.75	0.80
West Dakota	0.76	2.56	
East Nebraska	0.74	4.08	1.50
Middle Nebraska	0.65	3.16	.30 to 1.40, av. 1.
West Nebraska	0.40	1.42	Below normal.

3. To determine the degree of verification of the third prediction, the following statements as to the precipitation on the Pacific coast for April, May and June have been taken from the *Monthly Weather Review:*

"In April, 1889, the precipitation over the whole Pacific coast was *below* the nor-

mal, the most marked deficiency occurring on the South Pacific coast, where the average rainfall amounted to but 16 per cent. of the normal for the month. In the other districts the percentages of the normal were: Middle Pacific coast, 45 per cent.; North Pacific coast, 89 per cent."

"For May the average rainfall on the North Pacific coast was 2.9 inches, being .1 inch above the normal; on the Middle Pacific coast the rainfall was 2.5 inches, being 1.8 inches above the normal; and over the South Pacific region the rainfall was .34 inch, being .05 inch below the normal."

"In June the precipitation over the whole Pacific coast was below the normal, over the North and South Pacific being only one-half the average, and over the Middle Pacific being 86 per cent."

From these figures it may be considered that, of the three divisions into which the Pacific coast is divided, Mr. Blake's prediction was fulfilled in one — the Middle Pacific — and failed in the other two.

4. That there will be a "cold spell" sometime in April, *i. e.*, that a period of colder weather than the average will follow a period of warm weather, is about as certain as that there will be April showers, or snow in February. The fourth prediction, therefore, may be taken simply as a cautionary warning that is always applicable, or it may be meant to predict a cold spell of extraordinary severity.

The actual weather was as follows:

The lowest temperature in the State was 23° at Topeka, on one day. Prof. Snow, of Lawrence, states that his lowest temperature was 35°; that a light frost did no damage to peach buds; and that the weather throughout the month was highly favorable to crops.

Of 13 stations in eastern Kansas, five, and of 44 stations in middle and western Kansas only one-quarter, had any weather below freezing. The mean temperature for eastern Kansas, as well as for the whole State, was above the normal. The Bulletin of the Kansas Weather Service for May 4th reports "the preceding week a cold one for the season, with frosts in all but southeast counties; weather favorable for wheat, rye and oats, but too cold for corn and garden vegetables."

From these different statements it will be seen that if the prediction be taken to mean a "cold snap" of more than usual severity, as seems to be indicated by its prominence and by the 17° predicted for eastern Kansas, it was not a marked success. But if it be considered to mean *any* cold wave, then it was completely fulfilled, and Mr. Blake is entitled to all the credit which can be derived from it. In this case the prediction is without question a valuable one, but it exhibits a good knowledge of past weather rather than any special foreknowledge of the future.

5. From the *Monthly Weather Review* for July, I find that the temperature throughout the country east of the Rocky Mountains was either about normal or below normal, and for August the data at hand indicate that in general the summer *east* of the Mississippi was *cool*, and *west* of the Mississippi *warm or hot.* This prediction, therefore, is in the main unverified.

6. Hot winds prevailed in Kansas on the 5th, 6th, 7th, 26th, 27th and 28th of July. —*State Weather Service.*

"Wallace: Hot winds in fore part of August ruined corn in some sections."—*Report on Condition of Crops, Department of Agriculture.*

7. Of all the predictions made for 1889, no others are so often repeated and so strongly emphasized as the prediction of an extraordinary summer drouth; and the extracts that have been above given show the confidence with which the prediction was made, and the importance which the author attached to it. This prediction may therefore be considered to be pivotal in its character, and to contain a crucial test of the whole system upon which the tables are constructed. Moreover, because of

its unusual character the chance of accidental verification is small, and therefore a fulfillment would be the more striking and convincing. To give an account of the actual weather as contrasted with this prediction is an undertaking for which there is here no space. But for descriptions of the unprecedented rains, the disastrous floods, the extraordinary cloud-bursts, destructive washouts, bursting reservoirs and broken dams, of which the Johnstown calamity was the culmination but not the end, the reader has only to refer to the newspaper files from April to August, and to read the overflowing pages of the *Monthly Weather Reviews* for the same period. The reports of drouth, which in other years have generally occupied three columns of the *Weather Review* for the spring and summer months, have been diminished to a few paragraphs; and in midsummer (July) the only reports of drouth published are from the arid regions of Utah, Montana, and Nevada.

8. No reports of these predicted heavy August and September rains have been found.

9. Fully verified.

10. For Northern States not verified; for Southern States the crop is so unimportant that the crop bulletin of the Agricultural Department does not report it, but the prediction is quite safe, and has no doubt been fulfilled.

11. Verified; but the remarks appended to the discussion of No. 4 are in a measure applicable to this.

12. The actual prices have been placed for comparison in the above table with the predicted prices. No further comment is necessary.

13. The estimated corn crop made by the September Crop Report is 91 per cent.

14. The following table contains the predicted and the actual precipitation in Kansas from May to August, inclusive:

SUMMER PRECIPITATION IN KANSAS.

1889.	*Divisions of State.*	*Predicted.*	*Actual.*
May	Western	2.30	3.10
	Middle	3.50	5.90
	Eastern	4.50	7.40
June	Western	1.80	3.35
	Middle	3.56	3.90
	Eastern	3.60	4.80
July	Western	0.53	2.80
	Middle	2.83	5.00
	Eastern	1.75	6.20
August	Western	0.63	2.63
	North Middle	0.90	2.30
	South Middle	4.10	2.90
	Eastern	2.10	3.35

For December, 1889: The average precipitation was to be one inch and eighty-one hundredths (1.81) for Kansas; the records of the Kansas Weather Service observers show an average for the State of about four-hundredths (.04) of an inch. The average temperature for the State for December was to be 14°. The above-mentioned records put it above 40°; all reports stating that it has been the warmest and dryest December for the State on their records. The Government Bulletin says: "The month of December has been unusually warm in all districts east of the Rocky Mountains, while the normal temperature prevailed on the California Coast, and it has been slightly cooler than usual on the North Pacific Coast."

—The preceding comparisons of the predicted with the actual weather are sufficient for the purpose. What conclusion has been forced upon the reader? what are we to say about them as a whole?—for it is as a whole that they must stand or fall. Although desirous of finding and ready to welcome a real advance in predict-

ive meteorology, I state candidly, that although we have found a few verifications, yet the predictions as a whole seem to me to afford a poor showing. The present year has exhibited most striking and well-defined characteristics, and thereby has afforded a particularly good opportunity for one who with a true method should essay to predict its peculiarities. The winter throughout the country was generally mild. The spring and early summer east of the Mississippi river were characterized by almost unprecedented rains and floods, producing wide-spread ravages, and injuring or ruining many crops. In the northwestern territories of the arid region, on the other hand—Utah, Idaho, and Montana—a continued drouth has prevailed, and all vegetation has succumbed. In the Dakotas the rainfall has been very small, but still in many portions very good crops will be secured.

I submit that a weather prophet could scarcely have failed more signally in determining the marked characteristics of the seasons than has Mr. Blake with his cold winter, his hot summer, and his unprecedented drouth in the Northern States extending from the Atlantic seaboard to the Rocky Mountains, Kansas excepted. Instead of a cold winter, there was a mild winter; instead of a hot summer, the temperature has in general been below the average in Kansas and east of the Mississippi river; and instead of an unprecedented drouth, there have been east of the Mississippi river most extraordinary rains. The price of wheat, which was to have risen to $1.40 in July, has remained persistently low, and the Kansas farmers who held for a rise have seen the price steadily decline under the prospects of a magnificent crop.

In view of all this experience, the hard-working Kansas farmer will be too hard-headed to trust to weather tables "based on astronomical mathematics" which the author fails to publish to the world. Scientific men obtain their laurels by the fullest publication of their work; and one who refuses to make such publication deserves no following, for this of itself is *prima facie* evidence of presumption or fraud.

For the man who really accomplishes what Mr. Blake pretends, there awaits a position of power, a seat of honor, and the laurel wreath of fame. Science and industry will unite in placing on his head an imperishable crown, and the present profits of the sale of the "Annual Weather Tables" will be insignificant compared with the emoluments that the discoverer will receive. If Mr. Blake has a scientific method of weather prediction he should lose no time in presenting it in detail to the scientific men by whom its merits will be fairly judged, and in which way alone he can secure the rewards, money and medals sure to be awarded by kings and learned societies as due to so great a discovery. But in the absence of any such publication and its acceptance by other students of the weather, I earnestly call upon the farmers of Kansas to reconsider the grounds of their faith in these "Weather Tables," and rely upon their own enlightened energy and judgment to overcome the vicissitudes of seasons. A true knowledge of the climate of Kansas is being accumulated by the Kansas Weather Service, and everyone by taking simple observations may aid in its work. The relation of crops to climate is being studied by the agricultural colleges and experiment stations, and every farmer should read the publications of the State Board of Agriculture and of the Agricultural Department of the Government, in which the results of their valuable experiments are made accessible. It is in these directions that agriculturists may reasonably look to obtain a conquest over climate, rather than to the presumptuous predictions of professional prophets.

BOTANICAL NOTES, 1889.

BY J. H. CARRUTH, LAWRENCE.

A NEW GRAPE.

In July, 1883, the *Botanical Gazette*, published in Indiana, by Prof. J. M. Coulter, contained a description by Dr. Engelman of the Vitis palmata, Vahl. It is in no book which I have; not even in Oyster or Loudon. I copied the article in full. The chief points are that the young branches are red, angular, and ribbed; leaves palmate, with three or five lobes, the lobes widest in the middle, and narrow below; berries black without bloom, four or five lines in diameter; flowers in June, fruit ripe in October. Most like Vitis riparia. In the spring of 1887, I several times noticed in Lawrence, grape-vines with palmate leaves, and red, angular branches. Vitis palmata, I thought. In the spring of 1888, to see what the fruit would be, I took up two and set them in my garden. I got two, because our North American species are often imperfect, having only stamens. They grew, and three more came up of their own accord. Some of them grew more than twenty feet; but to my surprise, only the lower leaves were palmate, the upper ones being like those of V. cordifolia, or V. riparia.

In 1889 I thought I should have fruit; but when my vines blossomed, they had only staminate blossoms. I found one in the park which had perfect blossoms. The fruit in September was like that of the V. riparia.

Is it a new species. or only a variety of V. riparia? The mulberry, Morus rubra, has leaves both palmate and entire, and so some other trees. In the description of V. palmata, it was said to have seeds different from other species. This point I did not examine.

VITIS ÆSTIVALIS.

Wood, in describing this species, says leaves "with scattered ferruginous hairs beneath." Eaton says leaves "in their young state rust, downy beneath." Gray says, "young leaves downy, with large cobwebby hairs beneath; smoothish when old." I have seen them in New York State and in Kansas in September perfectly smooth.

The fruit is commonly about one-fourth of an inch in diameter. In 1879 I saw in Cherokee county a vine with fruit as large as that of the Concord.

ACER NIGRUM.

Wood, Eaton and Loudon call it a species; Gray makes it a variety of A. saccharinum. In Watertown, N. Y., the two kinds are used about equally for shade trees. There are no intermediates, which there would be if they were only varieties. The differences not mentioned in the books are that the leaves of A. nigrum are translucent, as one may see by looking through them towards the sun. A. saccharinum is not so.

The leaves of both have five lobes, the three upper ones large and having from the middle of each a projection half an inch long. The three lobes have each two angles. A. saccharinum has projections like those above mentioned from each of the angles, making nine in all. A. nigrum has no such projections from the angles —only three in all.

A. saccharinum is found in Miami and Linn counties. A. nigrum is abundant at Excelsior Springs, Mo.

POLYGANUM ERECTUM.

Wood and Gray both make it a variety of P. aviculare. Eaton and Loudon make it a species. If it was only a variety, the variations would not be constant; but they are. P. aviculare is never erect, but P. erectum is so always. The leaves of P. avic-

ulare are always brown; those of P. erectum bright green. I once saw the P. erectum growing right up through a patch of P. aviculare. They are as easily distinguished as any other two species.

PHYSALIS LANCEOLATA, PENNSYLVANICA, AND HÏRTA.

Gray makes all three of these varieties of the same. Wood makes the first two varieties, and does not mention the third. I have seen many specimens of all three. I have not noted a difference in the leaves or the flowers of the first two, but P. lanceolata is pubescent or puberulent; branches near the ground, is soon prostrate or leaning, only a foot high, blossoms in June, and its fruit calyx is cylindrical, more than an inch long, and has at the base a hemispherical depression.

P. Pennsylvanica is glabrous, has a clean stem half its height, always erect, height, twenty to twenty-four inches, blossoms in August, and its fruit calyx is broad-oval, three-fourths of an inch long, and has a convex base.

P. hïrta is very unlike to either of these. Stem and leaves pubescent, leaves entire, somewhat rhomboidal, twice as large as those of the other two, and the blossoms are all yellow. Mr. Gray was in a hurry when he said this was a variety of P. Pennsylvanica.

QUERCUS TINCTURIA AND COCCINCA.

The older editions of both Gray and Wood make them distinct species; the later make them only varieties. I cannot think of a reason for doing so. The leaves of Q. tinctoria are always obovate, those of Q. coccinea never. The full descriptions are as distinct as those of any other two species.

THE INSULATION RESISTANCE OF SOME ELECTRIC-LIGHT WIRES.

BY PROF. LUCIEN BLAKE AND H. RADCLIFFE, LAWRENCE.

The insulation resistance of electric-light wires is commercially of great importance. Leakage through defective or insufficient insulation represents not only expensive waste, but great danger to the generating machines by grounding them, and thus exposing their armatures to burning out. The element of risk to life and property also depends somewhat upon the character of the insulating sheath of the wires.

Ten years ago the so-called underwriters' wire was extensively and almost exclusively used for outside work, because recommended by the board of underwriters in New York. To-day, however, no thoroughly-posted electrician will use it, for it cannot resist moisture, and many fires in buildings and many burnings-out of armatures traceable to it have justly led to its condemnation.

At the present time there are some eight or ten well-known wires upon the market. The reputation of these wires has been established largely by the firms handling them, and not often have any scientific tests upon them been made.

The insulation sheath of an arc-light wire may be considered to have two functions, one electrical and the other mechanical, though the former is largely dependent upon the latter. Electrically, it must keep the electric current in the wire without leakage; mechanically, it must resist abrasion, heat, and moisture. The experience of any good and observant electric-light company will determine a wire's claims to the mechanical part, though wires have not been under trial a sufficiently long time yet to thoroughly prove them; a long-time exposure may develop faults not yet suspected; in fact, what changes may occur in the mechanical qualities of wires bearing for many years high-tension currents, we do not know. Particularly as re-

gards alternating currents, it seems to us highly probable that after some years the wires will show unexpected changes in brittleness and tensile strength. We know scarcely anything yet about heavy alternating currents.

Certain facts, however, in regard to the electrical qualities of an insulating sheath may be determined by tests. With this object in view, experiments were made in the spring of this year, in the physical laboratory of the State University, upon six of the principal arc-light wires in the market. All of them had been in outside use by the Lawrence Electric Light Company. These tests were made to determine the insulating power of the wires against leakage when exposed to moisture. The wires were No. 6, American wire gauge, guaranteed by the makers to be water-proof. Lengths of about 25 feet were taken, wound into coils, and immersed in large tubs filled with hydrant-water. The two ends of each coil projected about two feet out of the water. The coils were left in the water for nearly three months, measurements at first being made every day so long as considered necessary. The mode of testing was that known as the substitution method. One of the projecting ends of a coil of wire was connected to a delicate Wiedemann adjustable-coil dead-beat mirror galvanometer and to the positive pole of a single gravity cell. The negative pole was connected by a wire to a copper plate 20 inches square, which was placed in each tub of water, in the center of the coil. The other projecting end of each coil was left insulated in the air. Resistance boxes reading to 100,000 and 33,000 ohms, respectively, were so connected that they could be substituted in the circuit of the galvanometer and battery in place of any particular coil. For convenience, a special mercury switch was so constructed that the observer could throw in succession the different coils or the resistance boxes into the galvanometer circuit, and by equal deflections the resistances of the insulation sheaths could be determined. It is evident by the arrangements of the experiment, that only through the insulating layer of the wire could the current escape to complete the galvanometer circuit; and from the reputation of the wires, only a small leakage was to be expected. The insulation resistance should be several million ohms per mile. We have embodied our results in the form of curves indicated in the following diagram. (Explain curves.) After three months' immersion final tests were made, which gave the following results:

No. 1	7,200 ohms per yard.
No. 2	8,067 ohms per yard.
No. 3	816,000 ohms per yard.
No. 4	7,333 ohms per yard.
No. 5	3,702 ohms per yard.
No. 6	3,300 ohms per yard.

As the result of these tests, No. 3 is now used almost exclusively on the Lawrence electric light circuits; and at this writing, after nearly a year of out-door exposure, the insulation seems as perfect as at first.

ON BARITE AND ASSOCIATED MINERALS IN THE CONCRETIONARY ROCKS OF EASTERN KANSAS.

BY PROF. E. H. S. BAILEY, AND E. E. SLOSSON, LAWRENCE.

[*Abstract.*]

These rocks are found as boulders upon the hills in the vicinity of Lawrence, especially upon Mount Oread. It seems probable that there is a layer of these rocks below the surface. Similar boulders are found in Jefferson county along the line of the narrow-gauge road, in some places beneath layers of clay and above the lime-

stone strata. The rocks on being broken open are found to contain crystals of a white and a pinkish mineral, and numerous patches of sphalerite with small particles of pyrite. The associated rock is a gray, siliceous limestone, readily attacked by dilute acids. The minerals occur in radiated masses of thin bladed crystals and in veins of a centimeter or less in thickness, which divide the rock into irregular polyhedrons. The sphalerite is dark brown with yellow streaks, and has the ordinary resinous luster.

There seem to be two distinct minerals in the veins. One of them occurs in opaque pink crystals, and often in masses of irregular shape. These crystals decrepitate readily, and give both the barium and strontium flames. The streak is white, and there is slight effervescence with acid. An approximate analysis gives barium sulphate, 80 per cent.; strontium sulphate, 14 per cent.; with small quantities of silica and iron and calcium carbonate. This corresponds quite closely in composition to the so-called celesto-barite of von Waltershausen.

The second mineral when carefully picked appeared quite different. It occurs in transparent colorless crystals, varying in shape from flat rhombic to needle-shaped prismatic. In some places they are colored by red oxide of iron, which was removed as completely as possible. It decrepitates and gives a distinct strontium and a faint barium flame. Approximate analysis gives strontium sulphate, 96 per cent.; barium sulphate, 1 per cent.; with small quantities of silica and calcium carbonate, and shows it to be celestite.

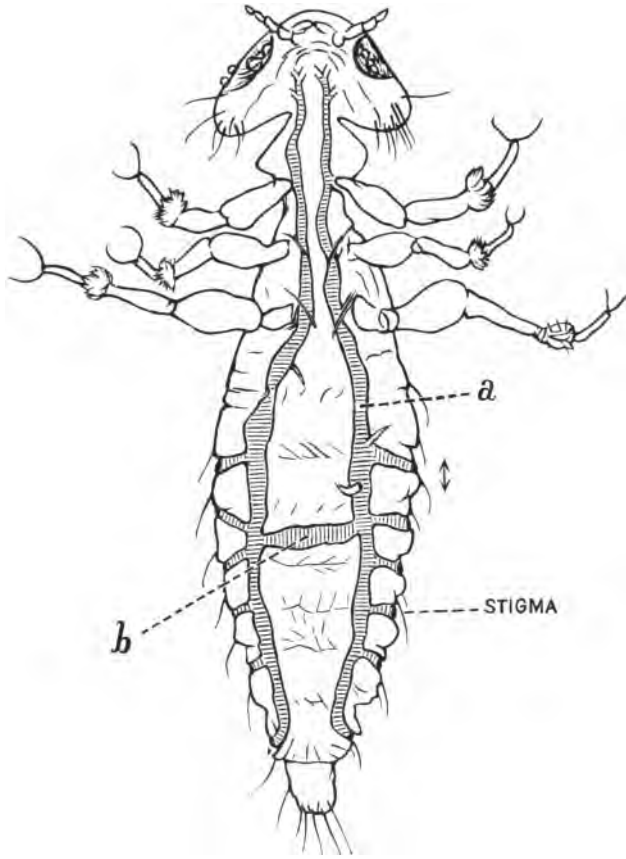
SOME NOTES ON THE MALLOPHAGA.

BY VERNON L. KELLOGG, LAWRENCE, KANSAS.

The Mallophaga (bird-lice) have been little studied. Nitzsch, and more recently Grosse, both of Germany, have devoted attention to the classification and to the anatomy of these insects. In the United States practically no work has been done in reference to them. As to anatomy, Grosse's "*Beitrage zur Kenntniss der Mallophagen*" may be considered the best authority, and as to classification, the scheme of Nitzsch is accepted. The Mallophaga have no well-defined position in the insect world. Packard in his latest publications arranges them with the white ants and stone-flies, making the order Platyptera.

The writer has noted and described, with full microscopic measurements, twenty-four species representing ten genera taken from Kansas birds. As no list of American species has been made, the specimens are arranged by genera and given species numbers. The writer discovers among these specimens types of two new genera which he introduces into Nitzsch's classification, and has fully described. Also are noted certain points which are essential to the classification of the Mallophaga and which are, with some hesitation, introduced into Nitzsch's scheme. Well-defined relations between certain families and genera of Mallophaga and certain orders and families of Aves are apparent, the distribution of the insects being evidently affected by the characteristic habits of the hosts. A series of forty specimens of Mallophaga, mounted on glass slides serves to exhibit external differences among the species so far observed. Observations on the anatomy, gross and minute, have been made to a limited extent, Dr. Grosse's monograph being very complete. Notes on the respiratory system of Tetropthalmus, as shown by accompanying cut of a clarified specimen have been made. Notes on alimentary canal content, upholding the declarations of Grosse that the Mallophaga eat feathers alone, and blood only indirectly, *i. e.*, when on the feathers by reason of a wound or mange, have been made. In observation of the digestive system in Docophorus, it is noted that the anus is a long

slit or line opening by the spreading apart of two lips, the excreta being ejected as a small pellet. Little observation of the young of the Mallophaga seems to have been made. The nymphs are very light colored, unchitinized specimens, and ex-



TETROPTHALMUS.—Showing respiratory system

a. Longitudinal tracheal trunk. *b.* Transverse tracheal trunk.

hibit large, unwieldy heads. From the notes on over fifty specimens measured, it may be said that the Mallophaga vary in length from less than one millimeter to five millimeters. In the following scheme of Nitzsch the points added by the writer are printed in italics. The table is slightly rearranged:

THE MALLOPHAGA.

With one (1) clawed feet—found only on mammals.
  With thread-like antennæ—three jointed; no maxillary palpi.....Trichodectes.
  With club-shaped antennæ—four jointed; with maxillary palpi.....Gyropus.
With two (2) clawed feet—found only on birds.

Philopteridæ.

With threadlike antennæ—five jointed; no maxillary palpi; *one (1) pair of simple eyes; one (1) jointed tarsus, blunt and rounded.*

Trabeculæ movable; feelers in both sexes, for the most part, without difference.

Head broad; abdomen short, elliptical; labrum generally with transparent projection ..... Docophorus.

Head somewhat elongated; abdomen long, with nearly parallel sides; no transparent labral projection... Nov. Gen.

Trabeculæ immovable.

Feelers thread-like, with sexual difference.

Hind head rounded—the male end segment rounded, Nirmus.

Hind head sharp cornered; abdominal segments blended in the middle..... Goniocotes.

Male feelers pincerlite, because of a branch on the third segment.

Hind head cornered; female end segment, warty; male end segment, rounded..... Goniodes.

Hind head, rounded; male segment, notched..... Lipeurus.

Liotheidæ.

With club-shaped, four-segmented antennæ; with maxillary=*labial* palpi; *with two (2) pairs of simple eyes; with lengthened, two-jointed tarsus.*

Without meso-thorax; feelers always concealed.

Head very broad, without orbital depression..... Eureum.

Head broad, with orbital depression, with greatly-developed ligula..... Nov. Gen.

Head elongated, with temple corners extending backward.

With sharply-cut-off clypeus, and shallow orbital depression..... Læmobothrium.

With only rounded sides of head, and long, side flaps on labrum..... Physostomum.

With meso-thorax.

Meso-thorax large, sharply defined; head three-sided; feelers concealed..... Trinotum.

Meso-thorax small, only perceptible.

Orbital depression deep; feelers mostly stretched out forward ..... Colpocephalum.

Orbital depression very slight or lacking; feelers concealed..... Menopon.

*Tetropthalmus.

The writer will gladly receive notes of inquiry or of interest in connection with the bird lice, and especially will be glad to receive specimens of lice taken from Kansas birds. Lice can be killed by immersion in dilute alcohol, and then taken out and sent, wrapped in paper, in common envelope.

*Tetropthalmus belongs, according to Nitzsch's classification, to Menopon; but Grosse decides it to be a new genus, and calls it Tetropthalmus on account of its four eyes, two pairs; but these four eyes are present in all Liotheidæ, so this is not at all a generic characteristic. However, on Grosse's authority it is introduced as a genus, and as it has not before been placed in the scheme the writer gives it its relative position in the classification.

METEOROLOGICAL SUMMARY FOR THE YEAR 1889.

PREPARED BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS, FROM OBSERVATIONS TAKEN AT LAWRENCE.

The most notable meteorological features of the year 1889 were the remarkable absence of extremes of heat and cold, resulting in a very mild winter and a very cool summer; the abundant and well-distributed rainfall making this one of the three wettest years on our twenty-two years' record; the phenomenally warm December, whose mean temperature was six and one-half degrees above that of November; the low wind-velocity; the small amount of snow; and the unusual number of fogs, averaging a little more than two per month.

TEMPERATURE.

Mean temperature of the year, 53.57°, which is .67° above the mean of the 21 preceding years. The highest temperature was 94°, on July 8, the lowest was 3.5° below zero, on the 23d of February, giving a range of 97.5°. Mean at 7 A. M., 47.91°; at 2 P. M., 61.67; at 9 P. M., 52.35°.

Mean temperature of the winter months, 34.22°, which is 5.43° above the average winter temperature; of the spring, 55.11°, which is 1.46° above the average; of the summer, 73.31°, which is 2.30° below the average; of the autumn, 51.66°, which is 1.90° below the average.

The warmest month of the year was July, with mean temperature 76°; the warmest week was July 16 to 22, mean 79.19°; the warmest day was July 7, mean 82.75°. The mercury reached or exceeded 90° on only 6 days (34 below the average number), all of which were in July. This is a most extraordinary deficiency of hot days, the smallest number of such days in any preceding years of our record having been 20, in 1877 and 1884.

The coldest month was February, with mean temperature 27.56°; the coldest week was February 17 to 23, mean temperature 13.56°; the coldest day was February 23, mean 5.50° above zero. The mercury fell below zero on only 4 days, all of which were in February.

The last hoar frost of spring was on May 3, the first hoar frost of autumn was on September 27, giving an interval of 147 days, or nearly five months, entirely without frost. This is eight days shorter than the average interval.

The last severe frost of spring was on March 28, the first severe frost of autumn was on October 27, giving an interval of 213 days, or exactly seven months, without severe frost. The average interval is 198 days. No frosts during spring or autumn caused damage to crops of grain and fruit, and for the first time in several years there was an abundant crop of peaches.

RAIN.

The entire rainfall, including melted snow, was 43.99 inches, which is 8.89 inches above the annual average. Either rain or snow, or both, in measurable quantities, fell on eighty-one days — twenty-one less than the average. On eleven other days rain or snow fell in quantity too small for measurement. The rain of the night of the 12th of August measured 5.68 inches, which surpasses any previous single rainfall on our record, the next to it being the 4 inches of June 13, 1876.

The number of thunder showers was 35. There were five light hail storms during the year — one in January, three in May, and one in June.

SNOW.

The entire depth of snow was only six inches, all of which fell in February. This is 15.96 inches below the average, and with the exception of the five inches in 1875, is the smallest annual snow precipitation on our record. Snow fell on 11 days, on 9 of which the quantity was too small for measurement. The last snow flurry of spring was on April 5th; the first snow flurry of autumn was on November 25th—17 days later than the average date.

FACE OF THE SKY.

The mean cloudiness of the year was 43.82 per cent., which is .3 per cent. below the average. The number of clear days (less than one-third cloudy) was 167; half clear (from one to two-thirds cloudy), 103; cloudy (more than two-thirds), 95. There were 87 days on which the cloudiness reached or exceeded 80 per cent. There were 60 entirely clear and 51 entirely cloudy days. The clearest month was August, with a mean of 33.36 per cent.; the cloudiest month was February, mean 51.78 per cent. The percentage of cloudiness at 7 A. M. was 47.69; at 2 P. M., 49.56; at 9 P. M., 34.21.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the N.W. 290 times, S.W. 213 times, S.E. 198 times, N.E. 168 times, S. 113 times, N. 46 times, E. 43 times, W. 24 times. The south winds (including southwest, south and southeast) outnumbered the north (including northwest, north and northeast) in the ratio of 524 to 504.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 120,230, which is 15,222 miles below the average for the preceding 16 years. This gives a mean daily velocity of 329.4 miles, and a mean hourly velocity of 13.73 miles. The highest velocity was 84 miles an hour, on August 12th, from 5:43 to 5:58 P. M.; the highest daily velocity was 1,030 miles, on the 29th of December; the highest monthly velocity was 13,380 miles, in May. The windiest months were May and December; the calmest months were June and July. The average velocity at 7 A. M. was 12.75 miles; at 2 P. M., 13.39 miles; at 9 P. M., 13.77 miles.

BAROMETER.

Mean height of barometer column, 29.125 inches, which is .018 inch above the annual average. Mean at 7 A. M., 29.145 inches; at 2 P. M., 29.107 inches; at 9 P. M., 29.121 inches. Maximum, 29.948 inches, February 23d; minimum, 28.415 inches, January 16th; yearly range, 1.533 inches. The highest monthly mean was 29.244 inches, in February; the lowest was 29.020 inches, in May. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 73.2; at 7 A. M., 82.1; at 2 P. M., 59.5; at 9 P. M., 78. The dampest month was September, with mean humidity 78.6; the driest month was April, mean humidity 61. There were 28 fogs during the year, which number has been but once equaled—in 1884. The lowest humidity for any single observation was 6 per cent., on November 6th.

The following tables give the mean temperature, the extremes of temperature, the number of inches of rain and snow, the number of rainy days, the number of thunder showers, the mean cloudiness, the relative humidity, the number of fogs, the velocity of the wind, and the mean and extreme barometer heights for each month of the year 1889, and a comparison with each of the 21 preceding years:

YEAR 1889.

Months.	Mean temp.	Max. temp.	Min. temp.	Rain, inches	Snow, inches	Rainy days	Thun. storms	Mean cloudiness	Humidity	No. of fogs	Miles of wind,	Mean barom.	Max. barom.	Min. barom.
January....	30.31	49.0	7.0	0.79	0	2	0	37.31	77.5	8	11,620	29.148	29.477	28.415
February ..	27.56	65.0	-3.5	2.20	6	6	0	51.78	76.0	3	11,020	29.244	29.948	28.570
March	44.73	71.0	22.0	2.30	0	7	2	42.80	69.4	1	11,110	29.127	29.539	28.600
April.....	56.37	86.0	35.0	2.52	0	8	5	44.16	61.0	0	11,550	29.095	29.496	28.551
May.....	64.23	89.0	38.0	8.27	0	14	8	48.47	68.9	0	13,380	29.020	29.394	28.617
June.....	71.24	90.0	51.5	4.04	0	7	7	39.56	73.3	2	6,860	29.061	29.401	28.664
July	76.00	94.0	56.0	6.34	0	10	5	45.05	75.5	0	7,070	29.052	29.264	28.845
August.....	72.69	89.0	57.0	8.38	0	7	6	33.36	78.1	2	7,840	29.154	29.460	28.979
September	63.17	89.0	38.0	5.02	0	9	0	42.06	78.6	3	8,830	29.101	29.555	28.836
October.....	53.56	89.0	31.0	2.09	0	6	2	49.25	72.2	4	8,510	29.178	29.525	28.771
November,	38.25	65.0	11.0	1.96	0	3	0	44.18	71.9	0	10,060	29.208	29.705	28.602
December,	44.78	72.0	11.0	0.08	0	2	0	47.89	76.3	5	12,380	29.110	29.679	28.429
Mean	53.57	79.0	29.5	3.66	0.5	7	3	43.82	73.2	2	10,020	29.125	29.536	28.673

TWENTY-TWO YEARS: 1868-1889.

Year.	Mean temperature	Maximum temperature	Minimum temperature	Hot days (Above 90°)	Zero days	Days between severe frosts	Rain—inches	Snow—inches	Rainy days	Thunder storms	Mean cloudiness	Humidity	No. of fogs	Miles of wind	Mean barometer
1868...	52.77	101.0	-16.5	43	7	160	37.48	27.5	77	.....	42.35	.....	.....	.....	.....
1869...	50.51	96.0	-5.0	23	2	167	38.51	18.0	105	33	49.23	78.2	19	.....	29.103
1870...	53.70	102.0	-10.0	51	6	197	31.32	9.5	100	27	47.88	68.4	13	.....	29.097
1871...	53.56	103.0	-6.0	48	8	218	33.23	29.7	120	24	47.37	65.9	6	.....	29.076
1872...	51.30	97.0	-18.0	45	16	192	32.63	23.2	116	40	44.33	64.4	11	.....	29.112
1873...	51.96	104.0	-26.0	48	9	165	32.94	26.5	101	17	42.46	64.0	6	154,508	29.093
1874...	53.68	108.0	-3.0	58	2	187	28.87	43.0	99	20	45.54	65.7	14	145,865	29.121
1875...	50.63	99.0	-16.5	32	12	196	28.87	5.0	106	21	44.81	66.7	5	145,316	29.102
1876...	52.76	98.0	-5.0	36	4	179	44.18	25.7	102	29	41.27	66.8	4	148,120	29.102
1877...	54.16	99.0	-9.0	20	3	217	41.09	15.5	126	39	47.12	72.6	11	113,967	29.117
1878...	55.31	98.0	-6.0	35	7	228	38.39	25.5	107	38	40.65	70.2	5	125,793	29.067
1879...	54.68	99.5	-16.0	48	13	203	32.68	10.3	90	36	40.01	67.1	10	124,768	29.127
1880...	54.00	101.0	-12.0	41	2	211	32.65	7.0	89	29	40.15	67.9	18	146,039	29.123
1881...	54.65	104.0	-8.0	68	6	210	33.27	32.5	110	31	47.42	70.1	11	141,430	29.103
1882...	54.94	105.0	-6.5	40	1	232	27.60	18.0	102	26	45.41	68.6	14	137,736	29.113
1883...	51.66	96.5	-14.0	26	8	217	40.65	12.5	106	32	45.24	69.7	18	141,164	29.135
1884...	51.30	98.0	-21.5	20	14	198	43.45	29.0	105	35	47.56	72.6	28	131,188	29.111
1885...	51.01	96.0	-14.5	27	21	176	36.97	33.0	103	31	44.57	71.3	9	123,013	29.107
1886...	52.96	105.0	-18.0	53	16	203	24.25	23.5	103	28	39.64	66.5	5	127,769	29.111
1887...	53.12	102.0	-20.0	40	16	203	33.84	25.0	91	23	40.91	69.8	13	132,367	29.109
1888...	52.28	99.0	-18.0	28	9	203	44.17	22.0	83	37	42.49	72.2	15	128,185	29.132
1889...	53.57	94.0	-3.5	6	4	213	43.99	6.0	81	35	43.82	73.2	28	120,230	29.125
Mean	52.28	100.2	-12.4	39	9	199	35.50	21.3	101	29	44.11	69.2	13	134,556	29.109

THE CURVE OF MEAN DAILY TEMPERATURES AT LAWRENCE, KANSAS, FOR TWENTY-ONE YEARS, 1868–1888.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

The accompanying diagram represents the curve of normal daily mean temperatures for 21 years. Upwards of 23,000 observations of Green's standard thermometers are condensed in this curve, the instruments having occupied the same shelter during the entire period of observation. An examination of this curve reveals the fact that the 8th day of January is, upon the average, the coldest day in the year, with mean temperature 18.04°; while the 15th of July is the hottest day, with mean temperature 81°. The coldest period in the year—the very heart of winter—is seen to be the 33 days from the 23d of December to the 24th of January, and the hottest period in the year—the highest heat of summer—is the 31 days from the 2d of July to the 1st of August.

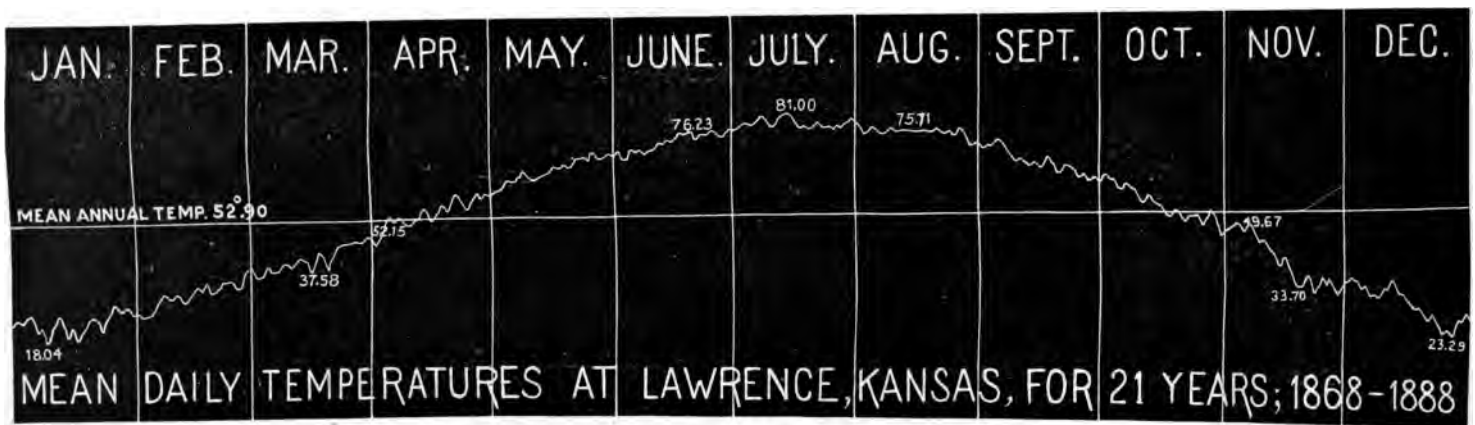
A remarkable rise in temperature takes place from the 20th of March to the 4th of April, the mean temperature increasing from 37.58° to 52.15°, or nearly 15°, in 15 days. This corresponds with the average time of blossoming of our fruit trees—peaches, plums, pears, and early apples.

A still more remarkable change in temperature takes place from the 7th to the 18th of November, the mean dropping from 49.67 to 33.70 degrees, or nearly 16°, in 11 days. This corresponds with the time when our base-burners, furnaces and other permanent heating apparatus are put into operation for the winter's campaign.

The real winter, however, may be considered as beginning on the 15th of December, when the mean daily temperature falls below the freezing point, not to rise above that point until February 15, making the average winter exactly two months in duration.

In like manner the real summer may be regarded as extending from the 17th of June to the 28th of August, this being the entire period during which the mean daily temperature remains above 75°. If, however, we consider summer heat to include the period whose average temperature exceeds 70°, the summer season will embrace the three and a half months from May 26 to September 8.

The remarkable fall in temperature from the 7th to the 18th of November would seem to dispose of the theory that the contact of the earth with the November meteors results in a marked increase in temperature of the earth's atmosphere.



CURVE OF MEAN DAILY TEMPERATURES FOR TWENTY-ONE YEARS.

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TRANSACTIONS

OF THE

TWENTY-THIRD MEETING

OF THE

KANSAS ACADEMY OF SCIENCE,

1890.

WITH THE REPORTS OF THE SECRETARY.

VOL. XII.

TOPEKA.
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TRANSACTIONS.

THE Kansas Academy of Science met for its twenty-third annual session at Lawrence, on November 5th, 6th, and 7th, 1890. The following extracts were taken from the minutes of the Secretary:

A business meeting was held at the Eldridge House, and the usual committees were appointed.

The other meetings were held in Snow Hall, at the State University. In accordance with a notice previously given, the amendment to section third of the Constitution was taken up, and it was unanimously voted that the annual fee of members be changed from two dollars to one dollar.

The following by-law, to be known as No. 11, was adopted: "Any section of these by-laws may be altered or amended by a two-thirds vote of members present." It was voted that by-law No. 6, in reference to the setting aside of one-fourth of the income of the Academy for the increase of the library, be stricken out. By-law No. 7, referring to the duties of the Librarian, was amended by striking out the word "sale." The reports of the Librarian and the Curator were made, and accepted. The report of the Treasurer, I. D. Graham, after being approved by the Auditing Committee, was accepted.

Bills to the amount of thirty-nine dollars and seven cents ($39.07), were allowed.

On Wednesday evening the address of the retiring President, Prof. G. H. Failyer, was given.

Thursday evening was devoted to a reception to visiting members, tendered by the University Science Club and citizens of Lawrence.

On Friday evening there was given an exhibition of lantern and microscopic slides.

During the meeting thirty-eight papers were read, and a number of others were read by title. There were twenty new members elected. The annual election of officers resulted in the following choice:

President—Robert Hay, Junction City.

First Vice-President—F. W. Cragin, Topeka.

Second Vice-President—O. C. Charlton, Ottawa.

Secretary—E. H. S. Bailey, Lawrence.

Treasurer—F. O. Marvin, Lawrence.

Librarian—B. B. Smyth, Topeka.

Curators—A. H. Thompson, Topeka; E. A. Popenoe, Manhattan; N. S. Goss, Topeka.

It was voted to hold the next meeting in the fall of 1891, at Ottawa.

On the following pages will be found papers read at this meeting.

PAPERS.

IODOFORM.

Preparation from Acetone and Hypochlorites; also, a Trial by Electricity.

BY S. R. BOYCE, LAWRENCE.

As everyone knows, the expensive part of iodoform is the iodine used in its manufacture, and as this constitutes by weight 96.69 per cent. of the finished product, it will readily be seen that its production must always be associated with expense. In working on a new formula for its production, the difficulty we aim to overcome is the appropriation of iodine to form iodides which are lost in or have to be recovered from the mother liquor.

The best yields I have been able to find on record from any of the old methods were recorded by Hager, who used Filhol's process and claimed 72 per cent. of the iodine appropriated; but Wilder, following the same directions, was able to obtain only 42 to 53 per cent. (Proc. Am. Phar. Ass. 1875, 717.)

We are now prepared to formulate a method by which practically all the iodine used is converted into iodoform and the reaction is completed at once without the labor and inconvenience of decomposing the mother liquor with nitric acid, as in Filhol's process.

The reaction is accomplished by the action of an alkaline solution of hypochlorite on potassium iodide in presence of acetone. The chlorine and iodine exchange positions, forming chloride and hypo-iodite. The iodine of the hypo-iodite immediately unites with a portion of the methyl in the acetone, and the solution becomes turbid from the abundant precipitation of iodoform. The greater part of the acetone appears to be appropriated to the formation of acetates and carbonates of the alkalies present. The following equation would probably approximate the reaction: $3\,KI+3\,KClO+C_3H_6O=CHI_3+3\,KCl+KC_2H_3O_2+2\,KOH$.

The operation requires no heat, and the precipitation is best conducted in a tall cylindrical vessel, allowing the solution of hypochlorite to fall into the other solution drop by drop as long as a precipitate is formed. The vessel should be large, as it requires about three parts of the former solution to one of the latter. As it is difficult to decant the hypo. solution perfectly clear, I prefer to place a filter over the receiver and turn on a small amount at a time, allowing it to drop as it comes through the filter. The constant dropping keeps the solution in motion; and in addition to this the receiver should be given an occasional rotary motion to facilitate the agglomeration and precipitation of the very minute crystals formed.

A complete precipitation can be accomplished in an hour; and if any considerable length of time is occupied, the solution should be protected from the light by wrapping a piece of paper around the container, or by other simple device.

The solutions are made as follows,* and special attention should be given to the amount of acetone used, since experiments proved that smaller amounts would give proportionately smaller results:

SOLUTION NO. 1.

Potassium iodide	gm. 50
Caustic soda	gm. 5
Acetone	gm. 40

Dissolve the KI and the NaOH in one litre of water, and add the acetone.

*Modification of a formula given by Sulliott and Raynand, *Chem. Zeit.*, Jan. 16, 1889. Also, *Bull. Soc. Chem.* 1889, 1, 3.

Solution No. 2 is the official Liquor Sodæ Chloratæ of the U. S. P., and should be added to No. 1 in small portions, as stated above. In preparing this solution, add more sodium carbonate if the calcium is not all precipitated.

In repeated operations I obtained 89 to 91 per cent. of the hypothetical amount of iodoform, which is equivalent to the same percentage of the iodine employed. The mother liquor contains 2 per cent. of the iodine as iodides, which leaves about 8 per cent. to be accounted for. We think by proper adjustment of the solutions the above 2 per cent. can be recovered as iodoform, and we are also of the opinion that the 8 per cent. mentioned exists as iodoform dissolved in the mother liquor.

Electricity.— Seeing statements to the effect that iodoform could be produced by electralizing solutions of the iodides with acetone or aldehyde receiving a continuous stream of CO_2, and the accompanying statement that if sodium or calcium iodide was used, the CO_2 was unnecessary. I thought I might be able to take a step toward bringing pharmaceutical preparations into communion with the electric age in which we live. I tried the experiment, and it was a *grand success.* With five Bunsen cells arranged in series, I was able to produce iodoform from all the different substances I tried containing iodine either free or in combination as soluble iodides. The precipitate formed slowly and steadily from all but the calcium iodide, from which it was thrown down very rapidly. But on examining the product, I was tempted to call it something like *iodocalioform* to indicate its true composition, containing 25 per cent. of calcium carbonate.

Electralysis of calcium iodide might be a profitable method for the preparation of iodoform, but since I tried it, I maintain that this method would be more consistent with the operations of the Physics Department than those of the Pharmaceutical.

ESTIMATION OF VOLATILE OIL IN MUSTARD.

BY L. E. SAYRE, LAWRENCE.

The object of this investigation has been to obtain, if possible, a simple method by which to estimate the value of mustard. The elaborate analyses recommended by different chemists, by which the various proximate principles of mustard are isolated and weighed, take considerable time, and admit of many sources of error. Hassell's method of estimating the volatile oil, by receiving the distillate from the aqueous mixture of mustard, in ammonia, evaporating, and weighing the crystals of thiosinamin, is apt to give variable results, because of the fact that the volatile oil escapes, to a greater or less extent, through the ammonia, in spite of the greatest care on the part of the operator.

The important constituents of mustard, it may be known, are *sinigrin* (myronate of potassium), from the black and *sinalbin* from the white mustard. Besides these they contain *myrosin*, which acts as an albuminous ferment. When powdered mustard is moistened this ferment acts upon the glucosides, forming volatile oil, sulphate of potassium and glucose as products of decomposition, or fermentation.

A favorite method of estimating mustard, by some chemists, has been to convert the whole of the sulphur contained in the mustard into sulphates by the action of nitric acid, and to estimate the sulphate by use of barium chloride, deducting from the total sulphates the amount of inorganic sulphates found in the ash.

It occurred to me that there might be a means by which mustard might be estimated by distillation of the volatile oil into some solution containing a substance which would unite with the sulphur or compound of sulphur so readily that none of

it could escape, and thus give us a ratio between this compound and genuine mustard. I can at present give only the result of a few experiments, and will not attempt to draw any definite conclusions.

Not until I have been able to make a number of experiments with our new method will I be able to say anything positive as to its merits as a guide in the estimation of this substance. If, however, I find by repeated trials that I can establish a definite ratio, I have here a method that will serve the purposes of the pharmacist admirably.

The pharmacist needs ready methods for quickly arriving at qualitative determinations; he needs easily-managed, practical methods to distinguish the genuine from adulterated articles. This gives rise to the particular kind of manipulations known to the pharmacist as pharmaceutical chemistry. While this process may not satisfy the analyst, it may be superior to other processes for the use of the pharmacist.

The apparatus I have decided upon after a long series of trials, consists of a condenser, graduated receiver, and a small Florence flask of two- or three-ounce capacity to take the place of a retort. The graduated receiver is about two inches in diameter, and contains 20 cc. of $\frac{N}{10}$ solution of silver nitrate, introduced from a burette. To the condenser is attached a tube which will just sit loosely in the receiver and extend to the bottom of the silver solution.

All joints are made air-tight by the use of perforated rubber corks and a moderate heat applied to the solution containing the mustard. Continue distillation till a vacuum is formed in the condenser, now remove the flame and the silver solution will be drawn up into the tube at the mouth of the condenser. Repeat the application and withdrawal of the heat till the volatile oil is all absorbed by the silver solution. A small tube closed by a stop-cock may be placed in the retort, and by blowing through this any vapor still in the condenser may easily be forced out.* Now titrate the silver solution (after noting its exact volume) with $\frac{N}{10}$ sodium chloride. Suppose after distillation our receiver contains 40 cc., or if not, it is very convenient to make it up to that amount with distilled water. Now suppose it required 10.7 cc. of this solution to neutralize 5 cc. of $\frac{N}{10}$ sodium chloride, then by proportion we find the amount of undecomposed silver nitrate. Subtracting this from the 20 cc. with which we started, we find the amount precipitated by the volatile oil:

10.7 : 5 :: 40 : 18.691—$Ag\ NO_3$ unprecipitated.

20—18.691 = 1.309 cc.—$Ag\ NO_3$ precipitated.

.016966—$Ag\ NO_3$ in 1 cc. × 1.309 = .0222 gm. silver nitrate precipitated by the volatile oil from .5 gm. of pure mustard.

CORRECTION.

BY N. S. GOSS, TOPEKA.

In my Revised Catalogue of the Birds of Kansas, I described what I then supposed to be the nest and eggs of the Sycamore Warbler—*Dendroica dominica albilora*. I am now satisfied that the evidence is not reliable upon which the entry is based.

I have met with the birds upon several occasions in the State, during the summer months, on the banks of the Neosho river, and always in or about the large sycamore

*The apparatus and manner of using it were shown to the audience.

trees; but I have never been so fortunate as to find their nest, neither can I find any authentic description of their nest and eggs. They undoubtedly nest in the tree-tops, like the eastern bird—*D. dominica.*

Information in regard to their nesting habits, etc., is very desirable.

SECOND OCCURRENCE OF THE WHITE-FACED GLOSSY IBIS—*PLEGADIS GUARAUNA*—IN KANSAS.

BY N. S. GOSS, TOPEKA.

A young female was captured October 17th, 1890, on the Arkansas river, near Wichita, and kindly sent me for identification by Dr. R. Matthews, of that city. The first specimen was shot in the fall of 1879, at a lake near Lawrence—as reported in my Catalogue of the Birds of Kansas—and is now in the fine collection in Snow Hall, at the State University.

RADIATION OF HEAT FROM FOLIAGE.

BY ALFRED GOLDSBOROUGH MAYER, LAWRENCE.

As the greater portion of the land-surface of the globe is covered with foliage, it becomes of extreme importance in determining the radiation of the earth, to know the radiation from foliage.

In order to determine this, the leaves were fastened to the side of a Leslie cube and exposed at proper intervals, so as to allow them to radiate upon a delicate thermopile.

The radiation of every leaf was compared with that of a similar leaf, lampblacked. The galvanometer used in connection with the thermopile was a Tomson astatic reflecting one. A falling screen was used to expose the thermopile to the radiation from the leaves, and readings of the deflections produced at the end of a half-minute and a minute were taken. In every case the thermopile was allowed to cool until the galvanometer came to 0 before taking another reading. In this way it was found that, if we call the radiation from a surface of lampblack 100, the radiation from various leaves was as follows:

Green poplar leaves	78–80.6
Yellow poplar leaves	71
Fresh brown elm leaves	74.5
Red oak leaves	83.7
Mullein leaves	74.3
Green elm leaves	79
Surface of lampblack	100

It was found that if leaves were cooled down by filling the Leslie cube with cracked ice, the radiation from all kinds of leaves was the same. Thus: lampblacked leaves, brown, green, yellow, or dried leaves, gave exactly the same deflection when cooled down so that a slight film of dew was deposited over their surfaces.

A side of the Leslie cube was cleaned and polished until it radiated only 14.3 per cent. of a lampblacked side, when both were heated to 212° F. When both were cooled, however, and a copious film of dew caused to form upon them by breathing on their surfaces, it was found that the polished surface radiated 96.8 per cent. of the lampblacked one.

By reversing the connections of the thermopile and heating the cube to the boil-

ing point, it was found by a simple calculation that a surface of dew radiates 62.9 per cent. of a lampblacked surface. All leaves covered with dew radiate 62.9, lampblack being 100.

We see from this that there is a considerable saving of heat in plants due to the deposition of dew upon their leaves. This saving probably amounts to about 15 per cent., for most plants.

A PARTIAL LIST OF PLANTS FOUND IN CHEROKEE COUNTY, TEXAS.

BY MRS. A. L. SLOSSON, LEAVENWORTH.

Allium striatum.....Wild onion.
Allium Canadense.
Allium mutabile.
Allium Carolinianum.
Acer saccharinum.....Maple, sugar.
Acer rubrum.....Maple, red.
Arisæma triphyllum.....Indian turnip.
Ageratum conyzoides.
Alyssum maritimum.
Achillea millefolium.....Yarrow.
Ascelepias tuberosa.....But'rfly weed.
Albizzia julibrassin.....Silk tree.
Anagallis arnensis.....Scarlet pim-
Anemone Caroliniana. [pernel.
Apogen humilis.
Ampelopsis quinquefolia..Woodbine.
Æsculus pavia.....Buckeye, red.
Æsculus flava.....Buckeye, yel'w.
Bumelia lanuginosa.....Shittim wood.
Baptisia perfoliata.....Wild indigo.
Coreopsis grandiflora. [purse.
Capsella bursa-pastoris...Shepherd's
Cassia chamæcrista.....Sensitive pea.
Callicarpa Americana.....Fr. mulberry.
Ceanothus mycrophyllus.
Corydalis aurea.....Ladies' ear-
Cynthia dandelion. [drop.
Centrosema Virginiana...Clitoria pea.
Crotolaria sagittalis.....Rattle-pod.
Cratægus crus-galli.....Hawthorn.
Cratægus cœcinea.....Hawthorn, red.
Carpinus Americana.....Hornbeam.
Castanea pumila.....Chinquapin.
Cerastium vulgatum.....Mouse ear.
Cardamine hirsuta.
Cercis Canadensis.....Red bud.
Claytonia Virginica.....Spring beauty.
Cornus Florida.....Dogwood.
Cuscuta compæta.....Dodder.
Chenopodium album.....Pigweed.
Datura stramonium.....Jimson weed.
Diospyros Virginiana.....Persimmon.
Dipteracanthus strepens.
Eupatorium aromaticum.
Œnothera fruticosa.....Eve. primrose.
Œnothera sinuata.
Œnothera linearis.
Œnothera riparia.
Fiscus carica*.....Fig.
Fragaria Indica.
Gaura biennis.
Gaura angustifolia. [press.
Gilia coronoptifolia.....Standing cy-
Geranium Carolinianum..Crane's bill.
Gledilschia triacanthus....Honey locust.
Gossypium album*.....Cotton.
Hibiscus esculentas*.....Okra.
Houstonia cerulea.....Innocence.
Hymenopappus scabiosacus.
Helenium autumnale.....Bitter weed.
Iris verna.....Blue flag.
Illex opaca.....Holly.
Hypaxis juncea.....Star grass.
Jatropha stimulosa, } Spurge
Cnidoscolus stimulosa, in Chap. } nettle.
Juglans nigra.....Black walnut.
Juniperus Virginiana.....Red cedar.
Lamium amplexicaule.
Lætuca elongata.....Wild lettuce.
Lathyrus myrtifolus.....Pea.
Pepidium Virginicum.....Tongue grass.
Linaria Canadensis.....Toad flax.
Lithaspermum canescens..Puccoon.
Liquidamber styraciflua..Sweet gum.
Lobelia leptostachys.
Lobelia cardinalis.....Cardin'l flower

*Not native.

Lonicera sempervirens...Honeysuckle.
Magnolia grandiflora.....Magnolia.
Marrubrium vulgare.....Horehound.
Maclura aurantiaca.....Osage orange.
Morus* (unknown).....Mulberry.
Morus alba.
Morus rubra.
Modiola multifida.
Melia azedarach*.....Pride of India; [China berry.
Mitchella repens.....Part'dge berry
Mollugo verticillata.....Shell flower.
Mentha peperita.....Peppermint.
Mendicago matriculata...Yellow clover.
Nymphea odorata.....Water lily—[pink.
Nicotiana tobacum.....Tobacco.
Nolina Georgiana.
Negundo aceroides.....Box elder.
Nepeta catoria.....Catnip.
Nepeta glechoma.....Ground ivy.
Opuntia vulgaris.....Prickly pear.
Ostrya Virginica.....Hophornbeam
Oldenlandia serpyllifolia..Bluets.
Oldenlandia rotundifolia.
Oxalis stricta.....Sorrel.
Oxalis viola.
Osmorhiza brevi-stylus...Sweet Cicely.
Papulus heterophylla.....Cottonwood.
Paulownia imperalis*....Imper'l tree of [Japan.
Podophyllum peltatum...Mandrake.
Phlox Floridana.
Phlox pilosa.
Penstemon pubescens....Beard tongue.
Passiflora incanata.....Passion flower.
Physalis lanceolata.....Ground cherry
Physalis nyctaginea.
Polygala pubescens.....Seneca snake-[root.
Polygala senega.
Phytolæca decandra.....Poke.
Philadelphus inodorus....Mock orange.
Polygonum aviculare.....Knot grass.
Pycnanthemum tullia....Horsemint.
Phorodendron flavescens..Mistletoe.
Portulaca oleracea.....Purslane.
Prunus chicasa.....Wild plum.
Prunus Americana.
Potentilla Canadensis.....Cinquefoil.
Phyllanthus Caroliensis.
Platanus occidentalis.....Sycamore.
Quamoclit cœcinea.....Cypress morn-[ing glory.
Ranunculus fasculata.
Rhus copallina.....Sumac.
Rosa lucida.....Wild rose.
Rosa lævigala.
Rubus vilosa.....Blackberry.
Rubus trivialis.....Dewberry.
Rubus villosus.....Blackberry.
Rhynchosia volubilis.... Wild bean.
Robinia pseudacocia.....Black locust.
Sisyrinchium Bermudiana, Blue-eyed [grass.
Sassafras officinalis.
Salvia lyrata.
Senecio lobatus.
Senebura pinnatifida.....Cress carpet.
Specularia perfoliata.
Smilax glauca.....Green brier.
Sagina apetala.
Sagina ellotti.
Solanum nigrum.
Scuttellaria parvula.....Skull-cap.
Sambacus Canadensis....Elder.
Symphorycarpus vulgaris.
Schrankia uncinata.....Sensitive brier
Stachys Floridiana.....Hedge nettle.
Trifolium Carolinianum..Wild clover.
Tecoma radicans.....Trumpet vine.
Tilia Americana.....Basswood.
Tillandria usneoides.....Long moss.
Vicia micantha.....Wild pea.
Verbena canescens.....Vervain.
Verbena officinalis.
Viola saggitta.....Violet.
Viola cuculata.
Viola rostrata.
Viburnum prunifolinum.
Vacinum.....Huckleberry.
Verbascum thapsus.....Mullein.
Vites æstivalis.....Wild grape.
Vites cordifolia.
Vites vulpines.....Muscadine.
Vernonia tomentosa.....Iron-weed.
Yucca filamentosa.
Yucca aloifolia.
Zanthoxylum Carolinianum, Prickly ash

*Not native.

CAMPS OF PREHISTORIC PEOPLE IN SEDGWICK COUNTY, KANSAS.

BY J. R. MEAD, WICHITA.

In the first exploration and settlement of the country adjacent to the Little and Great Arkansas rivers, in what is now Sedgwick county, Kansas, there were no evidences of previous occupation by savage or civilized people, such as mounds or broken pottery; and implements of stone were rarely found upon the surface. Yet the country was known to be a favorite camping-ground for Indian tribes, affording unlimited supplies of game, timber sufficient for their use and shelter, and pure, unfailing water in abundance, with fertile soil easily cultivated.

The alluvial soil, lacking stone on the surface, or cliffs of rock, furnished no material for enduring monuments or inscriptions.

The mound-building people did not flourish here, at least did not build mounds upon the convenient bluffs east of the river. If mounds were made in the valley, the tramping of buffalo and blowing winds may have reduced them to the common level. It is therefore evident that in seeking for traces of prehistoric people who may have occupied this valley, we must look beneath the surface; and here the expected evidence is found.

In 1864 the writer established a trading-post between the rivers, two miles above their junction, in a walnut grove, where converging bends of the rivers bring them near together, affording a beautiful and commanding location. Here hundreds of Indians camped, came and went, and built houses of logs or poles. Ten or fifteen years later this ground was a cultivated field, nothing indicating that it had been a scene of busy life, except a few stones and broken dishes; but every year the plow turns up, from deep in the ground, numerous stone implements of some former age and people, and unlike any found elsewhere in the country. The arrow-points, peculiar, all of one pattern, triangular, very small and delicate, lacking the usual notches, chips, and partly worked flint cores, show they were made where found. The material was similar to the chert formation about Joplin, Mo. Stone axes, and spear-points of jasper, were occasionally found, but no pottery.

Four miles south of Wichita, on the west side, eighty rods from the river, on the farm of Mr. Eldred, is the site of an ancient camp or village. Here are plowed up decayed pottery and very beautiful arrow-points of a reddish stone, skillfully notched, and all of uniform make and appearance, entirely unlike those above described, evidently made by a different people from a different pattern, and of material brought from some other source.

East of the river, on Chisholm creek, two miles south of Wichita, in excavating earth for brick-making, there were found, one or two feet beneat hthe prairie sod, numerous broken and one entire vessel of pottery; also spear-heads and scrapers. Near the mouth of the same creek there is an old camp, covering eighty or more acres; here are plowed up pottery, arrow-points, knives, scrapers, hoes, axes, hammers, pipes, and grinding-stones, of many different patterns and material; among others, pipes and unworked stone from the red pipestone quarries of Dakota. These can be seen in the collection of Mr. Frank Ford, at Wichita. A few years since, the caving of a bank on the Little river exposed a pottery vessel six feet beneath the surface. No obsidian or painted and glazed pottery has been found in these camps, which indicates that they were not of, or visitors to, the Pueblo people of New Mexico.

The Indians who frequented this region since it was first known to white men, did not make or use pottery; and as none has been found upon the surface, I conclude these camps may have, some of them at least, been made and occupied by unknown tribes many ages past.

The most remarkable find in this region, however, was made on the Whitewater river, twenty miles east of Wichita, and seems to date back in geologic times prior to the last general submergence of the country. At a point near Augusta the river has gradually deflected to the east, cutting its way slowly into the valley, exposing the strata of a perpendicular bank some forty feet in height. The top of the bank is the general level of the valley, in which was growing an oak tree five feet in diameter. The first eighteen inches in depth is the usual dark surface soil; the next eight feet is yellow clay, apparently of the Loess formation common in Kansas. This clay rests upon a former surface soil two feet thick, of rich black loam; the line between the two is sharply defined. The black soil merges into clay below, which extends down to gravel resting upon the bed-rock of the river. On the surface of the black soil and under the eight feet of clay I found the remains of a camp, containing broken pottery, charcoal, ashes, burnt bones, and stones such as would be used in a camp fireplace. The bones resembled the leg-bones of deer. The black stratum of soil was undoubtedly the surface of the valley, rich in vegetable and animal life, at the time the aboriginal, antediluvian people feasted around their camp-fire, and broke their soup-bowl.

We are evidently not the first settlers of Kansas.

DIFFERENTIALS OF THE SECOND AND HIGHER ORDERS.

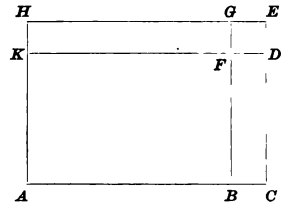
BY E. MILLER, LAWRENCE.

This memoir is written as an answer to one of many questions that have been addressed to the Department of Mathematics of the University. Such inquiries are of almost weekly occurrence. They cover ground that extends all the way from Problems in Percentage to "Curves of Pursuit." They embrace the "settlement of estates;" disputes arising from the "foreclosure of mortgages;" the winding-up of "joint-stock companies;" the contents of cisterns; the "horse power" of mill-dams; the properties of various kinds of curves; the Theory of Probabilities, and the elimination of differentials. More than once has the chair of mathematics been called upon to elaborate the principles, the notation, and the application of differentials, and to show why all differential expressions, of second or higher orders, when compared with those of the first order or degree, vanish completely from the work in hand, without affecting the result. To have answered this question in detail, by unfolding the demonstration step by step, as generally given by either of the methods of the Calculus, would have required more time and leisure than I had at my command. The proposer of the question was evidently laboring under the impression that to throw away the quantity $dxdy$ from such an expression as $xdy+ydx+dxdy$, was an absurd thing to do; believing that if dx and dy each had a value, however small, then $dxdy$ would also have a value, although indefinitely smaller than the former. Now, whether we use the Infinitesimal Method, in which "a quantity is conceived under such a form, or law, as to be necessarily less than any assignable quantity," and according to which infinitesimals of the *second*, *third*, and *higher* orders, may be dropped as not affecting the result; or, the "Method of Limits," as enunciated by one of the discoverers of the Calculus, that "quantities, and ratios of quantities, which in any finite time converge continually to equality, and before the end of that time approach nearer the one to the other than by any difference, become ultimately equal," *we know* that dropping the higher orders will give beyond a peradventure the exact result.

But without discussing the merits or the principles of either of these methods, it is proposed in this memoir to furnish a method that is rigorously exact, and does not depend upon any suppositions or theories, fictitious or otherwise. Sir Isaac Newton based his Calculus, or system of fluxions, as he called it, upon the doctrine of limits; but by reference to his Principia, Book II, Section II, Lemma II, it may be seen that there was in his mind a better and a rigorous method by which to obtain the desired results.

In order to illustrate the superiority of the Newtonian method over all others, take for example the proposition that the differential of the product of two variables is the differential of the first into the second, plus the differential of the second into the first.

First, by the infinitesimal method:

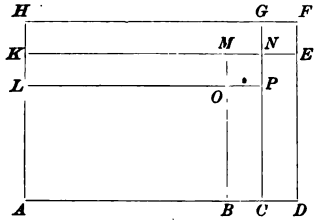


Let AB $= x$, and BF $= y$. Let — BC $= dx$, and FG or DE $= dy$. Then the area of ABFK will be represented by xy. Now, we shall represent the original value of ABFK by the equation $u = xy$.

By taking on increments the consecutive value of the function becomes $u + du = xy + ydx + xdy + dxdy$. Subtracting the first equation from the second, the result becomes $du = ydx + xdy + dxdy$. It is easily seen that ydx and xdy are infinitesimals of the first order, but $dxdy$, being the product of two infinitesimals, each of the first order, constitutes an infinitesimal of the second order, and therefore must be dropped. But $dxdy$ is the area of FDEG, and however small dx and dy may be, their product does represent some value. The method is very pretty, and reaches conclusions with less labor than by the doctrine of limits. Let us now examine Newton's Lemma II. It is as follows: "The moment of any genitum is equal to the moments of each of the generating sides drawn into the indices of the powers of those sides, and into their coëfficients continually." Newton then goes on to explain his Lemma thus: "I call any quantity a genitum which is not made by addition or subtraction of divers parts, but is generated or produced in arithmetic by the multiplication, division, or extraction of the root of any terms whatsoever; in geometry, by the invention of contents and sides, or of the extremes and means of proportionals. Quantities of this kind are products, quotients, roots, rectangles, squares, cubes, square and cube sides, and the like. These quantities I here consider as variable and indetermined, and increasing or decreasing, as it were, by a perpetual motion or flux, and I understand their momentaneous increments or decrements by the name of moments; so that the increments may be esteemed as added or affirmative moments, and the decrements as subducted or negative ones. But take care not to look upon finite particles as such. Finite particles are not moments, but the very quantities generated by the moments. We are to conceive them as the just nascent principles of finite magnitudes. Nor do we in this Lemma regard the magnitude of the moments, but their first proportion, as nascent. It will be the same thing if, instead of moments, we use either the velocities of the increments and decrements (which may also be called the motions, mutations, and fluxions of quantities), or any finite quantities proportional to those velocities. The coëfficient of any generating side is the quantity which arises by applying the genitum to that side." Newton then says that "the sense of the Lemma is, that if the moments of any quantities, A, B, C, etc., increasing or decreasing by a perpetual flux, or the velocities of the mutations which are proportional to them, be called a, b, c, etc., the moment or mutation of the generated rectangle AB will be $aB + bA$; the moment

of the generated content ABC will be $aBC+bAC+cAB$; and the moments of the generated powers A^2, A^3, A^4, $A^{\frac{1}{2}}$, $A^{\frac{3}{2}}$, $A^{\frac{1}{3}}$, $A^{\frac{2}{3}}$, A^{-1}, A^{-2}, $A^{-\frac{1}{2}}$, will be $2aA$, $3aA^2$, $4aA^3$, $\frac{1}{2}aA^{\frac{1}{2}}$, $\frac{3}{2}aA^{\frac{1}{2}}$, $\frac{1}{3}aA^{-\frac{2}{3}}$, $\frac{2}{3}aA^{-\frac{1}{3}}$, $-aA^{-2}$, $-2aA^{-3}$, $-\frac{1}{2}aA^{-\frac{3}{2}}$ respectively; and in general, that the moment of any power $A^{\frac{n}{m}}$, will be $\frac{n}{m}aA^{\frac{n-m}{m}}$. Also, that the moment of the generated quantity A^2B will be $2aAB+bA^2$; the moment of the generated quantity $A^3B^4C^2$ will be $3aA^2B^4C^2+4bA^3B^3C^2+2cA^3B^4C$; and so on."

We shall now illustrate Newton's method by the notation in common use:



Let it be required to find the increment of the rectangle ACNK. Let $AC=x$; $CN=y$; $BC=-\frac{1}{2}dx$; $CD=+\frac{1}{2}dx$; $MO=NP=-\frac{1}{2}dy$; $NG=EF=+\frac{1}{2}dy$. Now, let xy represent the value of the rectangle when it has reached ACNK. First, giving to x and y the increments $+\frac{1}{2}dx$ and $+\frac{1}{2}dy$, respectively, and *then* the decrements $-\frac{1}{2}dx$ and $-\frac{1}{2}dy$, we shall have:

(a). $(x+\frac{1}{2}dx)\ (y+\frac{1}{2}dy)=xy+\frac{1}{2}ydx+\frac{1}{2}xdy+dx.dy.$

(b). $(x-\frac{1}{2}dx)\ (y-\frac{1}{2}dy)=xy-\frac{1}{2}ydx-\frac{1}{2}xdy+dx.dy.$

Subtract (b) from (a), and there will remain the absolute increase of the rectangle, *i. e.*, $ydx+xdy$. In a similar manner, it can be easily shown that the increment of the volume xyz is $xy.dz+xz.dy+yz.dx$. Newton's method, therefore, is vastly superior to the others, in that it disposes of $dx.dy$, $dx.dz$, $dy.dz$, $dx.dy.dz$, dx^2, dy^2, etc., by a mathematical demonstration that is rigorously exact. That is to say, when those higher differentials are used in connection with differentials of the first order.

AN ELECTRICAL HYGROMETER.

[*Abstract.*]

BY LUCIEN I. BLAKE, LAWRENCE.

An hygroscopic substance, as chloride of zinc, is made the electrolyte in a galvanic cell. Variations in the amount of moisture in the atmosphere will alter the amount of this electrolyte and consequently the internal resistance of this cell. The cell itself is conveniently made by a strip of zinc and one of copper bridged by a piece of filter paper soaked in $ZuCl_2$. By connecting the poles through a sensitive galvanometer the deflections may be used as an indication of the amount of moisture present in the air. After five hours the polarization is about 20 per cent., hence it is practically *nil* during the time of an observation. Comparisons have been made for about a week with a Regnault's hygrometer. While the deflections followed the Regnault's with regularity, as yet the law connecting the amount of moisture and the deflections of the galvanometer has not been fully established. It is believed the instrument may be employed for a simple, inexpensive, and fairly accurate method of hygrometric observations.

FACIAL EXPRESSION AND ITS PSYCHOLOGY.

BY A. H. THOMPSON, TOPEKA, KANSAS.

The human face is said to be the mirror of the soul, because it reflects not only the static intelligence and refinement of the mind, but also betrays its transient emotions and passing impulses. The face is the servant of the emotions. It mir-

rors the feelings and gives expression to the impulses. It is the visible record, the map of the heart, advertising the character of the man to all who care to read. It is the herald of the heart, proclaiming the man. It betrays the impulses which underlie his actions. The face also serves the mind when it is affected by the heart and the emotions; and as most actions and thoughts are caused by the emotions, the face is often summoned to picture forth the feelings that affect volition. It thereby reflects the mind by betraying the impulses that prompt thoughts or actions. It is, therefore, the servant of the conscious activities. It does not reflect unconscious or automatic thoughts or actions. It is the mirror of the living soul, — not of the house in which it lives nor of the machine which it moves.

As Sir Thomas Brown said long ago, "There are mystically in our faces certain characteristics which carry in them the motto of our souls."

The face is the expressional area, *par excellence*, wherein the physiognomy of the individual, as revealing his character, is most indicated. The face is, indeed, physiognomy condensed. While it is but a factor of the sum total of the physiognomy of the individual, as expressed in all parts of the body, it is the most important factor, and is far more expressive than any or all the other parts. Physiognomy is merely a division of physiology — not an occult science for the reading of character — and indicates the impress of psychic influences upon physical structures; *i. e.*, the body takes the impress of the mind and heart, and their visible appearances are observed in the outward form and peculiarities of the individual. As thus indicating character, the physiognomy of the face is the concentrated expression of the peculiarities of his mind and heart. While character is revealed in all the parts of the body and their motions — the trunk and its carriage, the limbs and their gestures, and the walk, the head and its poise, the dress and its disposal — it is in the face that it is most clearly written. Indeed, very early in the history of the race it was noticed "that the good and evil passions by their active exercise stamp their impress upon the face, and that each particular passion had its own expression. From a very early age of human thought this fact attracted philosophic consideration." (Alex. McAlister.) As the "Son of Sirach" had it, "The heart of a man changeth his countenance, whether for good or evil."

Therefore the expressional duty of the face is to symbolize character. In common with the physiognomical functions of other parts of the body, the face assists in symbolizing the man, and depicts him as he is, in unmistakable signs. It is superior to them also in that it is the especial messenger of the emotions, and exaggerates the manifestations of character which the less effective parts merely indicate. The other parts bear a passive share in this symbolical work, but the face is active and aggressive. The symbols are not occult and secret and known only to the initiated, but are so open and plain that even a child may read and know plainly and simply the heart of the wearer of them. Of course experience and long and close observation of men increases the skill of and faculty in reading faces aright; but yet the power is instinctive in all men, for it is born with them, and is exercised unconsciously from the cradle. "I am much of Lavater's opinion," says Cowper, "and am persuaded that faces are as legible as books, and are less likely to deceive us; in fact, I cannot recollect that my skill in physiognomy ever deceived me."

The accomplishment of reading faces by the outward natural signs and symbols of character is valuable in proportion as men have dealings and intercourse with each other; and in this day of mutual and extensive dependence the faculty is of inestimable worth to all men. As a writer well says: "Knowledge of the world includes the ability to tell or guess well, at sight, what a man is, or will do, or feel, in certain events. It comprehends a swift and intuitive perception of character as displayed in form, and such a perception as penetrates far beneath the surface of

emotional expression right into the foundation forms in which are the true symbols of the mind's nature." Or as Henry Fielding puts it, "I conceive the passions of men do commonly imprint sufficient marks on the countenance, and it is owing chiefly to the want of skill in the observer that physiognomy is of so little credit in the world." Noble old Bacon hath it that "the lineaments of the body do disclose the disposition and mind in general; but the motions of the countenance do not only so, but do further disclose the present humor and state of the mind and will. Although physiognomy and related sciences have of late years been used to be coupled with superstitious and fantastical arts, yet, being purged and restored to their true state, have a solid ground in nature and are profitable in life." But Lavater, charlatan that he is, in spite of his sentimental assumption of character and mind-reading power and his fantastic use of physiognomy, has much to say that is of value and interest, when his voluminous observations can be culled of his intuitive and self-evolved philosophy. He says, truthfully, (Physiognomy, 1793): "He is a weak and simple person who affirms that all faces affect him alike. . . . The eye, the nose, the mouth, the forehead—whether considered in a state of rest or during their innumerable varieties of action—whatever is understood by physiognomy, are the most expressive, the most convincing picture of interior sensations, passions, will, etc., in fine, of all those properties which exalt the moral nature above animal life. . . . Physiognomy is the science or knowledge of the correspondence between the external and internal man—the visible superficies and invisible contents. It is, properly so called, the observation of character at rest, which is displayed in the form and appearance of the movable parts while at rest. Character impassioned is manifested by the movable parts in motion." Many grains of truth and reason may be gathered from the pseudo-scientist, Lavater's, ramblings, but the gathering requires the winnowing out of a deal of chaff. In replying to scoffers, he well says: "The human countenance, that mirror of Divinity, that noblest of the works of the Creator—shall not motive and action, shall not correspondence between the interior and the exterior, the visible and invisible, the cause and effect, be there apparent?" Or again: "All men (this is indisputable), absolutely all men, estimate all things whatever by their physiognomy, their exterior superficies. By observing these on every occasion they draw their conclusions concerning their internal properties." Truly no one could dispute such a self-evident truth; but then he goes on and loads it down with such a burden of fantasy about character-reading that, while he disclaims any such intention, he has done little to redeem physiognomy from its degrading association with chiromancy and the occult arts, and it remained what it had been for centuries—the synonym of quackery and imposture. Yet he wrote a great, if curious, work. It marked an era in the study of physiognomy, although his science is a burlesque and his philosophy a travesty. It has been said that "Lavater was guided in his estimates of character by a rapid intuition, by a kind of restricted perception, and his assurance of truth was but unintelligent conviction." His great work was too popular in style, and too unsystematic, to be of any great value to the world.

But, "to symbolize is not, indeed, the chief object of the construction of the bodily parts, nor of the features of the face. The general law of symbolic construction is that form is made to be significant without interfering with the fitness of parts for other purposes than those of symbolizing," as a writer says. In other words, the physiognomical function does not interfere with the physiological function, nor *vice versa*. "The features in which the symbols are most evident, have the fitness for breathing, speech, etc., or their primary design. But their being perfect for these purposes does not hinder their having also a symbolical meaning."

"The body and the mind, the sign and the thing signified do not correspond as

effect to cause, but as things derived from a common origin and planned with one design. . . . The Divine mind has made them both according to one idea, and there is perfect congruity between them, and in the visible the invisible is revealed. In this view the study of symbols in the human form is but a branch of that which seeks them in the whole world." The argument of design is, in our day, superseded by the principle of evolution; the mind and body are developed together and both partake, of course, of the hereditary influences which control the growth of both, and both are impressed also by the after experiences of the individual. "Men have in all ages been accustomed to symbolize their own ideas, and this is evidence of their consciousness that internal things may be aptly expressed in corporeal form, and they are affected by them as by the ideas which they incorporate. This establishes the antecedent probability of the doctrine of symbols in the human form.

"Thus, certain peculiarities of form and feature are so characteristic of the man, that we naturally call them masculine, while others are essentially feminine, because they are characteristic of woman. These signs symbolize the sexes. Feminine features in a man and masculine features in a woman always reveal a corresponding misplaced cast of mind. So it is with child-like features in adults. So the evident coincidence between national and mental characteristics presents us with a large series of symbolic forms admitting of rational interpretation." But the weakness of the whole system of physiognomical character-reading is in the inherent weakness of this same law of coincidence. A given expression and a given mental or emotional characteristic occurring together in a hundred cases might, if the observations were extended no further, be taken as revealing a relationship between them, and that they always occurred together. But if another hundred cases were observed, many exceptions to the rule would be found where the expression and the mental peculiarity occurred independently. Of course there are exceptions to all rules; but in physiognomy the exceptions are so numerous that it is unsafe, with all the experience of more than two thousand years, from Aristotle to Darwin, to attempt to formulate a law for character-reading.

"Another series of symbols are those of the likeness of the normal and constant features in some persons to those expressions which more commonly disclose the transient or habitual states of the mind. These transient expressions, as symbols universally acknowledged, by which the natural pantomime of life is carried on, indicate in their ordinary occurrence only the present or passing state of mind. They tell what the mind now is, but, by frequent repetition, the marks of any of them may become fixed in the features, and soon they indicate the acquired character — they reveal the habitual nature of the mind, and tell what the mind has become. But both the transient and habitual expressions must be distinguished from those symbols which, though like them and interpreted by them, are inborn, or which, as the features are gradually fixed, become more marked, even though the disposition which they commonly symbolize may be resisted, or, by education, quite suppressed; for these natural, permanent expressions are among the symbols which tell, not what the mind is or has become, but what it was or might have been. That the natural propensities, as indicated by the appearance, are often subdued, is a matter of common remark. 'I have seen,' says Addison, 'many an amiable piece of deformity, and have observed a certain cheerfulness in as bad a system of features as was ever clapped together, which has appeared more lovely than all the blooming charms of insolent beauty.'" It is the incongruities of physiognomy that militate against the pretenses of the character-reading theories; fine physical form of features by no means indicates a beautiful soul behind the face, and no more does mere physical deformity mean that the soul is deformed — although we would all prefer that a beautiful soul should look out of a beautiful face. It is too often this desire

to associate the two that leads to theorizing, upon the assumption that nature associates desirable internal characteristics with attractive features, and disagreeable dispositions with repulsive features; but, in reality, she does not do this at all, but gets them sadly mixed. In fact, it is impossible to bring character-reading down to a rational basis, and to classify expressions into a system. Lavater and his followers tried it, and failed. We can only judge of faces by our inherited instincts and intuitions. We can do little more than the child does — judge by the conscious effect expressions produce upon our feelings. In fact, expression is a thing of the feelings, and of the emotions. It is not of the mind, and therefore defies analysis, as do all phenomena of the feelings.

It is a matter of common observation that education, refined associations, and intellectual occupations, by elevating the mind, refine and spiritualize the face, in token of the refinement of the soul behind it. Thus the faces of persons with truly great minds — authors, artists, orators, statesmen, etc. — betray their greatness, and are an attractive study to persons of sympathetic intelligence. The faces, for instance, of Cardinal Newman, Savanarola, Gladstone, Lincoln, are beautiful even in their homeliness, because of the great souls which have stamped them with the seal of superiority. In ordinary life we recognize a "good face" as betokening a good heart, and are instinctively drawn towards it. When such a one possesses a high intelligence also, we look for a perfect man — one to trust and obey; for of such are they that lead men and move the world.

Of course there are exceptions to this rule. Refined faces are sometimes found among people of low intelligence and brutal tastes; but these are only erratic, and only indicate minds which by proper development amid favorable environments might have grown to something superior. They merely mean native superiority, latent and undeveloped. Or again, persons of education and refined associations sometimes have brutal faces; but these are only examples of misplaced education, the natural instincts not being of the high order that give the best results by training. But these are only exceptions to the general rule that a refined and spiritual face indicates either inherited or cultivated superiority, or both together.

It has been observed that faces grow in refinement as the mind develops. This is especially noticeable in schools and colleges, when the coarse, animal features of the child unfold and bloom into refinement and beauty as the education progresses. The face refines as the mind develops. And the person devoted to an intellectual or spiritual life reflects that life in his face, which grows more and more refined and beautiful as he pursues his elevating occupation and develops therein. The best examples of this development are found, of course, in those in whom the natural bent of the mind is favorable to such influences. Where it is unfavorable, the best of influences make but little impression.

Heredity has much to do, of course, with facial beauty and refinement. Generations of cultured associations and education will naturally produce faces of innate refinement and spirituality. If the course of such a life in a family is uninterrupted, it will lead more and more to beauty and refinement of features. But it is, unfortunately, rarely uninterrupted. There is degeneration in nearly every generation, either through crossing with coarser stock, or lack of education or moral influences or cultured associations, or the demoralizing effects of dissipation or low pursuits. So it comes about that coarse and refined faces occur side by side in the best of families, and often, also, in the worst. A refined face may appear in a coarse family, or a coarse face in a cultured family, through the workings of the law of atavism. That law will account for a low and brutal mind, a "black sheep," in the best of families, or of a refined individual in an uneducated and coarse family — the reäp-

pearance of former conditions. Such reäppearances are due entirely to hereditary causes, and are in no case sporadic or accidental. Nature always works by law.

When we reflect that it is but a very few generations since our ancestors were savages, and that the length of that savage life was incalculably long, as compared with the brief span covered by the civilized and historical era — during which countless impressions, physical and mental, were stored up and made permanent and transmissible — it is small wonder that low and animal instincts and tastes are so paramount in our lives. It is these impulses, inherited from that long and dreary savage life, that we have to combat continually as we strive after a higher life. It was during that period that the mind of man was evolved and differentiated from the mental organism of the mere brute. With the evolution of the mind, the face was developed and humanized, and, as it receded from the animal face and approached a higher form, it became the index of the human soul. The face of the lowest savage man is little above that of animals in expression (except of superior mental power), because the higher mental qualities and emotions are yet dormant. As he emerges from savagery into barbarism, he begins to feel somewhat for others, acknowledges that others have some rights, and from this stage the emotions are developed, and his subsequent refinement and elevation are assured. The mind was more or less fully grown in savagery, and what it has advanced since then is merely by means of the artificial culture which has been superadded. So it is that the face has undergone but little physical change in historic ages, but has changed only in refinement, by reason of the cultivation of the mind. If the child of any of the civilized races of men should be reared in savagery, without education, he would be but a savage; showing how near we yet are to our savage ancestry, and how easy is reversion.

With the birth of the emotions a great step forward was taken in the development of the face, for the emotions have much to do with facial beauty. A high intellectuality alone will not make a refined and beautiful face. Such a mind must be wedded to a warm heart to sanctify its mere strength. The noble impulses of great minds come from good hearts that prompt them to say and do great things for mankind. Lincoln's great deeds and sayings were due as much to goodness of heart, as to natural strength of mind. Napoleon was great intellectually in one direction, and by the brutal strength of his mind plowed his way through men and left death and misery in his path. He was so heartless and selfish that the world despises him as a man, and scarcely cares to admire his unquestioned genius. With the greatest of the world, as well as in ordinary life, it is the man who is kindest and best hearted, that has the most influence with his fellows. Good emotions are, in fact, the main factors of spiritual beauty; for the growth of the elevating emotions has a refining effect upon the face, and measurably atones for the absence of education or mental strength, which sometimes weakens a face. Thus the religious feelings have a perceptible effect on the face. Being the ally and messenger of the heart, and the emotions, it is but natural that the face should partake of the religious emotions and reflect them. Pure religion has a beautifying effect upon the face, and spiritualizes it. A highly spiritual life by the devotees of any creed, in which all selfishness and sordid things are excluded and forgotten, and the passions, which so distort the features, are completely restrained, has this ennobling effect upon the face, richly. This is always noted in the priests and disciples of any creed, whose faces have a peaceful and pure expression which nothing else can give. It argues that the passions and selfish feelings have the most degrading and disturbing influence upon facial expression, and that unselfishness and the contemplation of lofty themes have the most elevating and refining effect. But as the animal selfishness, which we have inherited from our savage ancestors, is yet the mainspring

of most of our actions, it is little wonder that there are few faces that are beautified by refined emotions and reflected unselfishness.

The struggle for existence in our selfish commercial life is quite as fierce as in the days of our ancestors.

The fittest in physical prowess survived then, and the fittest in commercial shrewdness survive now. There is a difference, however, that the unfit are cared for to some extent by the more fortunate in our day, especially when intellectually or spiritually superior. But the financial conflict and the grinding care this conflict brings upon all classes, weighs down the minds of men and furrows the face with lines. The daily anxiety about the means of living does more to destroy facial beauty than grief or suffering. It springs from and fosters selfishness and misanthropy, and crowds out higher thoughts and better emotions. It is this care and anxiety that destroys all traces of beauty, either natural or acquired, in ordinary faces. Surely civilization has done little for the struggling masses;—better the communism of barbarism than this soul-destroying conflict and anxiety!

And yet there some beautiful and spiritual faces to-day—the reflection of lofty minds and souls on which the sordid cares and anxieties and selfishness of life seem to have had little effect. They are such as have been saved by circumstances from toil and anxiety and are thereby enabled to give their thoughts to lofty themes, or those who by temperament are oblivious to care and carry the burdens of life lightly, or of those who by strength of mind ignore the petty things of life and live in a world of their own; or, more rarely, a face is illuminated by a soul lit by divine fires, and tells of a spirit not of our poor, common humanity. But the faces worth looking at and analyzing occur as rare oases in the desert of mediocrity around us, and serve but to redeem the mass from total condemnation.

Much depends upon contour, for beauty of the face. Youth is the season of freshness of beauty, as the face is then full and well rounded. This beauty of contour is produced by adipose tissue, and as age progresses this disappears, the features shrink and lose their expression, the muscles become less mobile, the skin loses its youthful color and texture, and, as the years toll off, the face assumes more and more the shape of the bony framework beneath, betraying approaching dissolution. Then, again, the experience of the years leaves its marks. The face in age may be serene and placid, or plowed with the furrows of suffering, as the life may have been happy or otherwise. Disease may also cause the face to shrink prematurely, and reduce the contour by emaciation. This, however, is usually corrected on the restoration of health by the redeposit of fat, except in the case of chronic disease and insufficient nourishment of the tissues. Contour is a principal element of beauty, in a mechanical and artistic sense, and, other things being equal, the plump face is the most agreeable and attractive. A certain amount of fullness, or tissue body, is necessary for the proper support of expression; for shriveled features cannot be expressive and active in conveying the workings of the mind.

Beauty everywhere is for enjoyment. Nature created beauty to excite pleasurable emotions. It never ministers to misery or pain. So, indeed, a beautiful face is created to be admired and enjoyed. The first thing that strikes us favorably in a face is exactness of proportion, and then harmony of the features, whatever the type. These give pleasure to our artistic sense, be it crude or cultivated; for the artistic sense is innate in all men. We enjoy a beautiful face, be it young or old, man or woman, as other beauties in nature or art, with an additional pleasure from the consciousness of it being living beauty, and that it is animated by a soul behind it whose beauty it reflects. So in the beautiful face of a child: it is the innocence and joy and freedom from care, that the face reflects, that attract us, while we admire the mere form and contour and color. So, also, with the face made beautiful

by intelligence and spirituality: we enjoy the contemplation of it for what it represents, and it lifts us above our sordid selves. The ethical effect of this spiritualized beauty in man or woman has a powerful influence for good, and it is felt by all men more or less consciously. A good face does good by its mere presence among men, and the influence of such a person cannot be estimated. But facial beauty is so varied, and standards vary so much, that, taking all classes and tastes, perhaps there may, after all, be very few healthy faces that are not attractive and more or less beautiful in some eyes — dull and commonplace as the majority of them appear.

ON THE OCCURRENCE OF MAMMOTH REMAINS IN FRANKLIN COUNTY, KANSAS.

BY O. C. CHARLTON, OTTAWA.

Through Franklin county from west to east runs the Marais des Cygnes river, which is the upper course of the Osage river. The mammoth remains which I first mention were obtained from the N. E. ¼ of the N. E. ¼ of sec. 17, town 17 S., range 21 E.

Nineteen years ago De Witt C. Estes, who then owned the land, found at the base of the low bluff skirting the river on the north, a part of a tusk and a large bone. The piece of tusk was 18 inches long, and apparently composed of ivory, which was easily separated into thin, concentric scales. In 1880 W. P. Estes found, washed out in the river-bed at the same place, a vertebra having a spinous process nearly 18 inches long. Other loose parts of large bones have been found in the river-bed below this point, near Rantoul.

In May, 1889, a part of a jaw and one tooth were found. The tooth weighs 9 pounds. Last November W. P. Estes found, in same bluff, a shoulder-blade over 3 feet long, which was broken in removing it, and soon thereafter mostly crumbled to fragments. The firmer articulating end, now in the museum of Ottawa University, has a maximum diameter of 11 inches.

At this bluff the river runs in a curve convex to the northeast. The bluff is composed of 12 feet of soil and brittle clay, under which is 9 feet of whitish friable clay, underlaid by one foot of gravel resting on shale, which latter forms the river-bed. Just over the gravel the bones were found. Since 1860 the river has washed away perhaps 35 feet of this bank. Within fifteen years it has here transferred its channel from the west to the east side of a small island. Besides, the overlying clay is quite irregularly stratified, just where the bones were removed. Hence my conclusion that the bones of the skeleton were widely scattered.

Other mammoth remains have been found, in the city of Ottawa. About twelve years ago, when digging a well at No. 418 Main street, the workman, at a depth of 22 feet, came upon a mammoth skeleton, about 300 lbs. of which were removed. It was embedded in mixed clay and gravel. A part of one tooth, recently presented to our museum by Dr. H. B. Paramore, weighs 22 lbs. Part of another weighs 17 lbs.

It may be well to add that wood, not badly decayed, has been obtained at a depth of 22 feet, in Forest Park, and fragments of bones have been taken out of the river bank above Ottawa, 18 feet below the surface.

PRELIMINARY OBSERVATION ON THE DESTRUCTIVE BURROWING OF SHALE.

BY O. C. CHARLTON, OTTAWA.

The shale rocks exhibited were obtained but a few hours before the meeting of the Academy. They are completely honeycombed by some burrowing animal not yet examined. The tubular cavities are about one-tenth inch in diameter, and, in some of the rocks, so close together that they are too fragile to admit of handling, even gently, without crumbling. Living animals are found only in rocks covered by water. Large numbers of the loose rocks are being thus destroyed.

PERIODICITY IN PLANTS.

BY B. B. SMYTH, TOPEKA.

I.

That plants have a regular time each year for leafing, blooming, and fruiting, is a fact well known. From the first blooming of the white elm early in March, or even in February, to the final blooming of the sow thistle (Sonchus asper) in November, there is a constant succession of bloom, and each and every plant passes through the successive steps of its development in its appropriate season. There may be a difference in early spring of as much as thirty days in the first blooming of certain plants, according to the advancement of the season. As the summer progresses the differences of time of first blooming in different years decrease, until in midsummer it is rare to find a difference so great as ten days in the different years; and later in the fall it must be an unusual year indeed that makes even so much of a difference as ten days to occur in the first blooming of a plant at any one place. Hence, in general terms, a late spring, an early fall, and a short growing season, hastens the growth and development of a plant; and a long season retards the maturity and increases the growth of a plant.

But, generally, plants are so prompt about their motions, such as the opening of leaves and flowers, that an average day may be taken for the first blooming of any individual species, and that particular species will be ordinarily found in bloom within three days from the appointed time, but oftener on the particular day. This refers especially to particular plants in a certain location.

Not only does each species have its set time for performing its different functions, but in any species each different variety has its own time, often differing widely, as in the ripening of apples. Further than that, each individual tree has its own certain time for opening its leaves, blooming, and ripening its fruit, from which it seldom or never varies a day in years having equal temperature during the days and months preceding the looked-for phenomena. For instance: a large male cottonwood tree in Mr. F. W. Giles's park at the northeast corner of the State yard comes into bloom usually about April 12th, and in four days it has shed all its blossoms. Two days later, April 14th, a large male cottonwood tree in the State yard, between the east wing and the arsenal, opens its blossoms. On the 15th it is fairly magnificent in its wealth of bloom, and two days later it has shed every blossom. Five days later a large male cottonwood in Dr. Gibson's yard, 300 yards distant to the southwest, expands its flowers and for two days is a most beautiful object, and

then promptly sheds its limp aments with their depleted anthers. Between the extremes mentioned, or say between April 10th and April 25th, every cottonwood tree, male and female, in and around Topeka, has fulfilled its estival mission and started in untold numbers the germs of future cottonwood trees.

II.

Not wishing to dwell on the annual periodicity of development in plants, features that are so well known, I turn now to the second division of this subject, and speak of certain daily motions in plants, showing that they are cognizant of light and darkness, as of heat and cold. In addition to that, I will attempt to show that plants are sensitive to varying conditions of the atmosphere, to touch, and even to contiguity of objects.

Plants can feel, of course; but do they actually see?

How often have we seen potato-sprouts, turnip-tops, and other plants in the cellar, stretching out as far as possible and leaning over in an attempt to reach the window where the only feeble rays of light enter the cellar. In the same way you have all seen, in the open air, the leaves turn their faces up to the light, and when they grow on the side of a house, turn sidewise to the light; and if under a roof, will still turn their faces toward the brightest light. And the tendrils, those modified forms of leaves, always turn away from the light.

We are not aware that we are cognizant of light by any organ except our eyes, and we call that seeing. The plant is cognizant of light in its leaves, in all their modifications. Is it not, at least, analogous to seeing? Is it heresy to say that, so far as light is concerned, plants can see?

Everybody knows that the morning glory opens in the early morning, and that the evening primrose opens about sunset; but not everyone knows that each different species of flower opens regularly each day at its own appointed hour. For instance, our common morning glory (Ipomœa purpurea) opens before 5 o'clock, and the blue morning glory (Ipomœa hederacea) opens after 5, or about an hour later. Similarly, our wild bush morning glory of the prairies (Ipomœa leptophylla), the immense roots of which many of our western Kansas farmers have encountered with the plow, opens at 4 o'clock in the morning, very regularly; and two other species of morning glory, both with small white flowers, open still earlier. One of these (Convolvulus arvensis) has small, arrow-shaped leaves, and creeps on the ground; the other (Ipomœa lacunosa) has medium-sized, heart-shaped leaves, with a small lobe on each side, and climbs. Both of these have tuberous roots, and hence are, in a sense, perennial. The common white morning glory of our hedges and thickets (Convolvulus sepium) opens very early in the morning, perhaps soon after midnight; and yet another, the common white creeper (Convolvulus spithamæus), opens several hours before midnight, or late in the evening; hence is called the evening beauty. Several other species of Ipomœa, commonly called moon-flowers, open at early evening and close at daylight.

One remarkable thing about this family of morning glories remains to be told: all the night-blooming species are pure white, and all the morning-blooming kinds are colored. True, there are white varieties of many of the day-blooming kinds, as a white variety of the purple morning glory, a white variety of the blue morning glory, a white variety of the red-flowered cypress vine, etc.; but in all of these there are traces in the center, or along the ribs of the corolla, of the original color, and none of them is pure white.

The evening primroses, too, have just as great variation in their times of blooming. Thus, the common great-flowered evening primrose (Œnothera grandiflora) opens very promptly at 7 o'clock in the evening, and wilts about 7 o'clock next

morning. A still larger and more remarkable flower (Œnothera missouriensis), not found in gardens, but on the rocky hills of eastern Kansas, opens more promptly at 7 o'clock, or just about sunset. A smaller-flowered species (Œ. sinuata) opens earlier, or about 6 o'clock. The handsome white evening primrose, so common in the streets of Topeka in the summer-time, and that keeps its flowers open so nicely all day, I have not yet learned when they open, as I have never yet had the pleasure of seeing one unfold its petals. But there are numerous species that open during the day, and it is to be noted that each species has its own regular time for opening.

The gauras, belonging to the same family, are just as regular in their habits. Gaura coccinea, the scarlet gaura, opens at 6 o'clock in the evening, is a pure white all night, and changes to a beautiful rose-color at daylight; which color deepens slightly until early afternoon, when the flower wilts. Gaura biennis, a tall weed with long, slender, far-reaching branches, opens its pure white flowers an hour after dark, from 8 to 9 in the evening, and remains open until about 10 o'clock next day, still very white, but changing slightly to rose-color before fading. Gaura parviflora, known by its soft, silky leaves, opens at the same hour, closes a little earlier, and changes strongly to rose-color before fading.

How many have noticed our common jimson (Datura stramonium) opening from 5 to 6 o'clock every evening? Just as regularly it closes early in the morning. Several of our cultivated jimsons (Datura metel, etc.), with their beautiful large white flowers and delightful fragrance, open very promptly at sunset, and close just as regularly in early morning.

Another group of flowers noted for their great regularity is our wild four-o'clocks. The common kind, with the large, heart-shaped leaves (Oxybaphus nyctagineus), opens its flowers very regularly every afternoon at 4 o'clock, even much more regularly than the four-o'clock of the gardens. Another (O. angustifolius), with a deeply-lobed white calyx, opens at 5 o'clock, or from that to 6. All the species of Oxybaphus open late in the afternoon. Abronia fragrans, a handsome sand-hill plant of the same order, opens at 6 in the evening.

Another plant of an order allied to the morning glories, and with a strong tendency to periodicity, is Heliotropium convolvulaceum, which is common on the sandy plains of southwestern Kansas, and spreads its sweet-scented white trumpet flowers in early twilight.

Several plants of an order allied to the evening primroses, and somewhat to the poppies, are periodic in the time of opening their flowers. Mentzelia oligosperma opens early in the morning and closes about one o'clock in the afternoon. Mentzelia nuda, with remarkably large, creamy-white flowers, opens at three o'clock in the afternoon, with its buds all turned toward the southwestern sky, so that the flowers open directly in the face of the sun, just as the daily temperature has begun to decline. Mentzelia ornata, with still larger, yellowish-white flowers, opens an hour or two later. Both of these close early next morning, and remain asleep all day to reopen in the afternoon.

The regularity of opening of many members of the chickweed and purslane families is well known, the former flowers opening in the evening, the latter in the morning. Somewhat allied to this last is the cactus family, the regularity of blooming in certain members of which is well known.

These observations, with others unmentioned, may be tabulated into what may be called

A FLORAL CLOCK FOR KANSAS.

2 to 3 A. M....Convolvulus sepium; closes next evening.
3 A. M.....Ipomœa lacunosa; closes about 2 P. M.

3 to 4 A. M....Œnothera speciosa; lasts all next day.
4 A. M.....Ipomœa leptophylla; closes at noon.
Convolvulus arvensis; closes at 10 A. M.
4 to 5 A. M....Ipomœa purpurea; closes about noon, except when the weather is cool and cloudy.
5 A. M.....Ipomœa hederacea; does just about the same.
Mentzelia oligantha; closes at 1 P. M.
5 to 6 A. M....Commelyna virginica; closes in heat of day.
Tradescantia virginica; closes after noon.
Evolvulus argenteus; closes at 4 P. M.
6 A. M.....Castalia odorata; closes at 3 P. M. to reopen.
Pyrrhopappus scaposus; closes at 6 P. M. to reopen; closes also in continued rain or dense cloudiness.
Sonchus oleracea; withers at noon.
7 A. M.....Callirrhoe involucrata; closes 6 to 7 P. M. to reopen next day.
Troximon cuspidatum; closes at night to reopen.
Taraxacum dens-leonis; closes at dark to reopen, except in rainy weather, when it may be closed in daytime and open at night.
7 to 8 A. M....Oxalis stricta; closes at noon for good.
Oxalis violacea; closes at noon to reopen?
8 A. M.....Linum rigidum; falls off at 4 P. M.
8 to 9 A. M....Specularia leptocarpa; closes permanently at 2 P. M.
9 A. M.....Portulaca pilosa; closes at 1 P. M.; does not reopen.
Portulaca grandiflora; closes at 2 P. M. to reopen.
Portulaca oleracea; wilts after noon.
10 A. M.....Mesembryanthemum spectabile; closes at 2 P. M. to reopen for several days.
11 A. M.....Talinum têretifolium; closes in afternoon.
Mesembryanthemum crystallinum; closes to reopen.
12 M.....Hibiscus trionum; closes again at 2 P. M.
1 P. M.....Silene antirrhina; lasts until night.
2 P. M.....Mamillaria vivipara; closes at 5 P. M. to reopen next day.
Mamillaria missouriensis; does the same.
3 P. M.....Mentzelia nuda; closes at daylight to reopen.
4 P. M.....Mirabilis jalapa.
Oxybaphus nyctagineus; closes next day.
4 to 5 P. M....Oxybaphus angustifolius; closes 5 A. M. next day.
5 P. M.....Mentzelia ornata; closes in the morning to reopen.
5 to 6 P. M....Silene noctiflora; wilts next morning.
Datura stramonium; wilts next morning.
6 P. M.....Œnothera triloba; lasts nearly all next day.
Abronia fragrans; wilts early in the morning.
Gaura coccinea; fades next day.
6 to 7 P. M.....Heliotropium convolvulaceum; wilts next day.
Œnothera sinuata; wilts next day.
7 P. M.....Datura metel; closes and wilts next morning.
Œnothera missouriensis; wilts at sunrise.
Œnothera grandiflora; opens very promptly; wilts at 7 A. M. next day.
8 P. M.....Gaura biennis; wilts about 10 A. M. next day.
Gaura parviflora; does the same, pretty much.
9 P. M.....Ipomœa bona-nox; closes early next forenoon.

10 P. M.....Phyllocactus phyllanthus; closes before daylight to reopen for one or two times.
10 to 11 P. M...Cereus grandiflorus; closes before morning.
11 P. M.....Cereus speciosissimus; wilts at 2 A. M.

The above clock is the result of many years' observation; yet it is still subject to some correction. Most of the plants in the above list are native in Kansas; a few are introduced or cultivated, as Taraxacum dens-leonis, Portulaca grandiflora, the mesembryanthemums, Mirabilis Jalapa, Datura metel, Ipomœa bona-nox, and the last three cacti.

In cases where a flower reopens for several successive days, it will be seen that the stigmas and stamens are ready for action on different days.

An idea has already been touched upon that is foreign to the subject of this paper, namely, that night-blooming plants are always white or yellow; and on the other hand, all blue, purple, and red flowers are day-blooming—not that all yellow or white flowers are night-blooming, or that all day-blooming flowers are blue, purple, or red.

Why are night-blooming flowers white or yellow? Isn't the reason for this very clear? They can be distinctly seen for long distances by night-flying insects.

It may be seen that many plants have preferences among the insects. For instance: Œnothera missouriensis admits the cecropia moth only; no other moth has a sucker long enough to reach the nectar, which is at a depth of nearly six inches; and no other moth is so well adapted to perform the important office of fertilization. Œnorthera grandiflora admits both cecropia and polyphemus moths; other species of œnothera are not so particular. Again, the red clover, with its large stores of honey, does not admit the common honey-bee; so that that insect must confine its labors to white clover or elsewhere. The red clover prefers the bumble-bee; and the form of that insect is found to be best adapted to fertilization of that plant.

So it may be found that every kind of flower has one or more particular kinds of insect best adapted to it, and opens at the time of day only when such insects are on the wing.

One curious feature in this connection may be mentioned: The common prickly pear (Opuntia missouriensis) conceals no nectar; but its stamens are not merely sensitive—they are irritable to a high degree; and when an insect, attracted by the sight and odor, alights upon the flower, the stamens immediately spring in upon him from all around and cover him with pollen. Taken by surprise, he immediately flies away, perhaps to another flower of the same kind, to be treated in the same manner; but, in all probability, the prominent style of the prickly pear is ready to receive the pollen, and quickly catches some of that which the insect has brought with him from a neighbor.

III.

I now come to the third part of my paper, a certain series of motions in leaves, tendrils, suckers, etc., depending upon the time of day or the requirements of the plant. It goes without saying that the roots of a plant shoot downward and the stem turns upward. That is, they do that as far as circumstances will admit. If a plant start in a perpendicular bank the roots run into the bank and downward; the stem outward and upward.

If the plant be a twining vine, as soon as it has attained sufficient length, the terminal bud commences to move around in a circle, the hop around to the right, looking outward from the center, the morning glory to the left. As the vine grows it increases gradually the circle in which it moves, until finally it touches something

or drops to the ground from exhaustion or its own weight. As soon as it has touched something, it makes a short, quick turn and wraps around it, though it may be only another similar vine unable to support it.

These motions result always in each plant growing in the place that is best adapted to its growth. Why, for instance, does the Ampelopsis virginica climb a tree, or a stone or brick wall in preference to a bush or a haystack? The tendrils of the Ampelopsis at first, like the tendrils of a grape-vine, seek the dark side of the vine, and finding a solid vertical support that they cannot grasp, accommodate themselves to the conditions and flatten the tips, forming sucking disks that take firm hold of the tree or the face of the brick or stone. Here the vine thrives best; and all that portion of the vine leading to the tree, which may be fifty feet from where the Ampelopsis seed germinated, dies, giving the vine the appearance of having germinated at the base of the tree or wall.

A very large wistaria was climbing a stone house, partly by trellis, partly by strings. An apple tree stood near, whose branches reached close to the wistaria vine. Thinking to have part of the wistaria climb the apple tree, I separated some of the vines and laid them over on the branches of the apple tree. But they refused. In three days all the vines had turned toward the house, and some of them had reached back to the main vine by the house. Several attempts of the same kind resulted in failure. The vines came back from the apple tree and climbed the other vines by the house at last. The young vines, clinging close to the house, reached far from the supporting trellis, and climbed over the eaves, clinging close by some means, but so effectually that the storms of winter or summer fail to dislodge them.

A climbing ivy, in order to hold to a tree, sends out numerous rootlets from any place along the dark side of the vine; and the ampelopsis has its sucker-like tendrils at the joints; but how does the wistaria manage to cling? In this case branches act as tendrils, partly. They bend around projections, and, stiffening with age, hold the vine. Temporarily, leaves do the same thing until the branches have grown.

Leaves, like flowers, often have certain times of the day for opening and closing. Most noticeable among these are certain species of Euphorbia, notably E. serpyllifolia, E. glyptosperma, E. maculata, E. humistrata, and E. Preslii; also the dogbane Apocynum androsæmifolium. These plants all have opposite leaves, and in the case of the euphorbias, oblique, or lefts and rights; and as soon as the dew begins to fall, they fold together in pairs, as a child folds his hands to pray, and, with the light-colored under-side out, remain thus all night.

Many of the leguminosæ, notably cassia, desmanthus, and desmodium, fold their leaflets at night. These leaflets are jointed to the midrib, and the midrib to the branch, by noticeable articulations that allow a motion of both leaflet and leaf. Daylight opens the leaflets and raises the leaf. Thus, leaves are said to be asleep when they are closed for the night.

But not all plants fold their leaves with the faces together, as do the plants of the pea family. The sorrel, for example (Oxalis stricta and O. violacea), folds its leaflets back to back, and the whole leaf droops from its junction with the petiole. Again, Abutilon avicennæ, with its very large, velvety leaves, droops straight down from the junction of the blade with the petiole; the petiole remaining in its normal position, and the leaf hanging face outward.

Everyone, probably, has seen the sunflower turn its leaves eastward to the morning sun, and westward in the evening. Many other plants do precisely the same thing, among which may be noted beans, ragweed, rosinweed, marigold, and many

other plants of various families. One notable plant of this character is a certain variety of Hosackia Purshiana, whose leaves turn eastward in the morning and westward in the afternoon. To facilitate this, all the branches and leaves grow toward the north and south, so that the leaves simply have to turn over. In the case of the Silphium laciniatum, where the two surfaces of the leaf are just about alike, the leaves do not turn one face upward, but stand vertical, with one face to the east and the other to the west, and with the edges north and south. Thus, the leaves, which are rigid, get the benefit of all the sunlight; and the plant only grows on an open prairie, in a sunshiny country.

AN IMPROVED FIRE-SCREEN; AND NOTES ON THE THERMAL RESISTANCE OF FIRE-SCREENS.

BY T. H. DINSMORE, EMPORIA.

[*Abstract.*]

This fire-guard is so constructed as to secure neatness of design and unusual security from fire. The subject of thermal resistance of fire-screens is reviewed, and it is shown that resistance varies directly with the distance from the fire, and inversely with the meshes of the guard.

METHODS OF COLLECTING, CLEANING AND MOUNTING DIATOMS.

BY GERTRUDE CROTTY, LAWRENCE.

The diatomaceæ, called by the writers of the early part of this century bacillariaceæ, are now generally considered to be unicellular microscopical algeæ. This classification is based upon their usual method of reproduction — that by fission or division. Several eminent scientists, however, as Dr. Farlow, of Harvard College, yet hold that, on account of their freedom of motion, they ought to be placed in the animal kingdom.

The first forms of this microscopical plant were discovered at the close of the last century by the celebrated Danish micrographer, O. F. Müller. There have now been described over ten thousand varieties. This number is enormous, considering the fact that American forms have been little studied. With the exception of the late Prof. H. L. Smith, America has not produced what Dr. Henri Van Heurck means by his term "diatomophile." Owing to the fact that allowance has not been made for degeneration in size of any variety, due to division, it is very probable that this number has been unnecessarily increased.

Each individual diatom is incased within a silicious covering. This covering is composed of two halves, or valves, one fitting over the other as does a lid over a box. The point of union, the point where these two valves overlap one another, is termed the connective zone or girdle. These valves are marked by rows of punctures, or stria, except at the center, and frequently each end. The unstriated points are the nodules. These nodules are united by a line, the raphe, or median line. Each cell or plant contains a nucleus and nucliolus, protoplasm and a greenish-brown substance — the endochrome; likewise, several oily globules. Each plant is also covered by a mucilaginous coating, which may be detected by

staining. I have observed thirty or forty diatoms of one variety adhering together by means of this covering, sometimes in a solid phalanx, and again drawn out in a line, until the tips only, of the frustules, overlap.

Let us return, for a moment, to the process of division. That agamic bipartition cannot continue indefinitely without senile degeneration is evident; and the first sign of degeneration is reduction in size. By division the cell contents first separate, and then the two valves; two new valves of silica having been secreted. Hence, each of the two new individuals is again incased within a silicious shell composed of half of the old frustule and half of the new. It is evident that the new plant, possessing the lid for its outer covering, would be larger than the one incased within the box. Hence, let me say again, that size cannot be a very important factor in determining a variety.

The process of division continues with wonderful rapidity. Prof. H. L. Smith says: "I have been unable to ascertain the time occupied in a single act of division, but, supposing it to be completed in twenty-four hours, we should have as the progeny of a single frustule the amazing number of 1,000,000,000 in a single month." Others claim that the division is completed in three and six hours.

My purpose, however, is not to consider methods of reproduction, but to tell you, from my limited experience, what methods I have found most convenient for collecting, cleaning and mounting our Kansas varieties.

Light and moisture alone are necessary for the development of diatoms; hence, they may be found in running or standing water, but never in putrid water. In case the growth is luxurious, they will be found as a greenish-brown layer upon submerged stems and leaves of plants, upon rocks, or the surface of mud. In Kansas they are usually found upon the surface of the mud — our streams have usually mud bottoms. By means of a shallow dipper or long-handled spoon, the collector may obtain a quantity of this slime, mixed with earth. The fluid thus collected should be well shaken and poured into a flat dish, where it is allowed to settle for several hours. The heavy earthy particles will sink to the bottom of the dish, while the surface will be covered with a thick brownish coating. All the supernatent water should be poured off gently, or, better, carefully removed with a small pipette. Gently touch the dry finger to the green covering and wash off the adhering particles into a small vial. If care is taken that the touch be light, diatoms almost entirely free from foreign matter may be obtained. I have frequently tried the well-known process of gigging, but have invariably failed to obtain pure diatoms, since our fine clay will be held in suspension as readily as will the light diatoms. Moreover, the clay of Douglas county contains so much silica, that, once mixed with the cleaned diatoms, it is almost impossible to extricate them from the white, clinging, flocculent mass. Any chemical which will destroy the flocculent silica will also attack the frustules.

The pure diatoms, once obtained within the vial, may be cleaned — or, in other words, freed from their cell contents — in various ways. A very common and useful method is to boil them in acid — sulphuric, nitric, or hydrochloric. I usually boil them in concentrated sulphuric acid, and destroy the carbon thus formed with nitric acid. A test tube will be found a very convenient receptacle during boiling. Allow the liquid to cool, and, after a few hours, the diatoms will have settled to the bottom of the tube. Pour off the supernatent acid and fill the tube with pure cistern water, or, better still, distilled water. Again allow the contents to settle, and pour off the water. Repeat this process until all traces of the acid have been removed. Be not discouraged if it is necessary to repeat this process twenty or thirty times. Once freed from the acid, the beautiful white frustules are ready for mounting.

Dry upon a slide or cover-glass a drop of the pure water containing them. Care

should be taken that the water used for washing is chemically pure, or else crystals will be formed, attaching the diatoms to each other or to the slide. Moreover, if all the acid has not been washed out, crystals will likewise be formed. As an instrument for picking up the diatoms, a sharpened swine's bristle or a mouse's whisker will be found most excellent. If the experimenter wishes to mount them free-hand under the microscope, this bristle may be fastened to a pen-holder or any handle by means of a drop of wax or Canada balsam. Since a diatom $\frac{1}{1500}$ of an inch long is considered above the average size, and few of the varieties found about here are of the larger varieties, one finds free-hand mounting almost an impossibility. I experimented for three months last spring, and was rewarded by a loss of patience and enthusiasm, but succeeded in acquiring a steady hand, and alas! but five mounts. By using the mechanical finger, however, I have succeeded within the last month, working at odd moments, in selecting out and mounting about fifty varieties. All these varieties have been selected from collections made from one stream. I usually select out eight or ten of a variety and transfer them to a cover-glass lightly coated with glycerine. The glycerine is evaporated by the heat of an alcohol lamp, leaving the diatoms firmly attached to the cover-glass. A drop of Canada balsam is placed upon a slide, and the cover-glass is gently dropped upon the balsam. The slide is kept for several days with the cover-glass side downward until the balsam is sufficiently hardened to prevent any change of position taking place.

I might venture to add that, like other plants, certain varieties of diatoms seem to flourish at different seasons of the year. Perhaps my observations are too limited to allow me to make, with any definiteness, such a statement. From the same ravine, however, I made collections last February and May. The varieties that prevailed in February were fewer in May. Collections made from the same place in September of this year show that varieties seldom seen in the spring—for example, Pleurasigma, Navicula, and some of the Surirella, as robusta, are plentiful. While some varieties so common in the spring, as Surirella spiralis, I have failed to find at all this fall. Whether these varieties "run out," so to speak, and regenerate more frequently than once a year, that is, at more than one season of the year, I cannot of course determine from but one year of observation. It is evident that they have resting seasons. I might add, however, that some varieties, as Synedra, seem to be uniformly distributed throughout the seasons.

A COMPARISON OF PRESERVATIVE FLUIDS FOR MUSEUM USE.

BY V. L. KELLOGG AND E. E. SLOSSON, LAWRENCE.

[*Abstract.*]

A satisfactory preservative fluid for museum use, especially for the preservation of insect forms, is a desideratum of much importance. Much trouble and lack of success is experienced in the endeavor to preserve specimens without shrinkage, or swelling, or loss of color. A satisfactory preservative fluid for biological collections in entomology must perfectly, or as nearly perfectly as possible, preserve the animal tissue from deterioration, and must not change the colors. Alcohol is the most commonly-used preservative fluid, but while preserving the tissues, it affects colors in almost all cases. Specimens kept in glycerine frequently retain their colors, but are likely to fall to pieces on being handled. Carbolic acid effects marked changes in the tissues.

The experimenters have prepared an extensive series of preservative fluids, so-

lutions of salicylic, boracic, and similar acids, naphthalene and the metallic chlorides, separately and in combination, and in various strengths of alcohol and glycerine.

With these fluids, tests are being made by immersing insect larvæ and imagines, of all of which specimens careful notes respecting color and measurements are made before immersion in the fluids. Inspection is made frequently, and any changes in the specimen are noted. Especially valuable results are expected from simultaneous experiments on a large number of larvæ of the same species of lepidoptera. For example, a number of larvæ of an Arctian moth, all taken at one time and all of nearly equal age, introduced into a series of different fluids, show especially well by comparison the effects of the various preservative agents.

The experimenting was begun too recently to allow of any collaboration of results thus early. At a future meeting of the Academy, the experimenters hope to present the result of their work.

IMAGINARY FOCAL PROPERTIES OF CONICS.

BY H. B. NEWSON, LAWRENCE.

In modern geometry, the foci of a curve are defined as the points of intersection of the tangents to the curve from the imaginary circular points at infinity. Since four such tangents can be drawn to a conic, and since four lines intersect in six points, it would seem that every conic has six foci. But the circular points at infinity count for two; so there are only four finite foci, two real, and two imaginary. Many authors refer to the existence of the imaginary foci. C. Smith, in his conic sections, page 205, has shown that the imaginary foci are a pair of conjugate imaginary points, situated on the minor axis equi-distant from the center. Elsewhere (Annals of Math., vol. V., page 1) I have called attention to the fact that imaginary focal properties of conics may be developed which are the counterparts of the real focal properties.

I propose in this paper to set down in parallel columns the real and imaginary focal properties of conics, so that the reader can see at a glance what theorems concerning imaginary foci correspond to known theorems concerning real foci. I shall give first the theorems for the ellipse. They are given without proof. The simplest method of proof for the imaginary properties is to change a into b, and x into y, in the ordinary demonstration of the real properties.

REAL.	IMAGINARY.
The sum of the distances of any point on an ellipse from the real foci is constant, and equal to $2a$.	The sum of the distances of any point on an ellipse from the imaginary foci is constant, and equal to $2b$.
The real eccentricity is $e=\sqrt{\frac{a^2-b^2}{a^2}}$.	The imaginary eccentricity is $\acute{e}=\sqrt{\frac{b^2-a^2}{b^2}}$.
The distance of either real focus from the center is ae.	The distance of either imaginary focus from the center is $b\acute{e}$.
The length of the real semi-latus rectum is $a(1-e^2)$.	The length of the imaginary semi-latus rectum is $b(1-\acute{e}^2)$.
The lengths of the real focal radii are $a \pm ex$.	The lengths of the imaginary focal radii are $b \pm \acute{e}y$.

The polar equation of an ellipse, a real focus being a pole, is

$$r = \frac{a(1-e^2)}{1 \pm e \cos. \theta}.$$

The locus of the foot of the perpendicular from either real focus on a tangent is the major auxiliary circle.

The rectangle contained by the perpendiculars from the real foci on a tangent is constant, and equal to b^2.

The real focal radii to any point on an ellipse make equal angles with the tangent at that point.

The major axis of an ellipse is divided by a real focus into segments, such that their product is equal to b^2.

The distance from the center to where the normal cuts the axis of x, or the subnormal, is e^2x^1.

A circle of radius a described from the extremity of the conjugate axis cuts the transverse axis in the real foci.

The polar of either focus is a directrix.

The distance from the center to either real directrix is $\frac{a}{e}$.

The distance of any point on an ellipse from a real focus is in a constant ratio to its distance from the corresponding directrix; this ratio is equal to the real eccentricity of the conic.

The equation of the tangent at the extremity of the real latus rectum is $y + ex = a$.

The equation of the normal at the same point is $y - \frac{x}{e} + ae^2 = 0$.

The circle described on a real focal radius as a diameter touches the auxiliary circle.

The polar equation of an ellipse, an imaginary focus being the pole, is

$$r = \frac{b(1-\acute{e}^2)}{1 \pm \acute{e} \sin. \theta}.$$

The locus of the foot of the perpendicular from either imaginary focus on a tangent is the minor auxiliary circle.

The rectangle contained by the perpendiculars from the imaginary foci on a tangent is constant, and equal to a^2.

The imaginary focal radii to any point on an ellipse make equal angles with the tangent at that point.

The minor axis of an ellipse is divided by an imaginary focus into segments, whose product is equal to a^2.

The distance from the center to where the normal cuts the axis of y, or the conjugate subnormal, is $\acute{e}^2y^1$.

A circle of radius b described from the extremity of the transverse axis cuts the conjugate axis in the imaginary foci.

The polar of an imaginary focus is an imaginary directrix.

The distance from the center to either imaginary directrix is $\frac{b}{\acute{e}}$.

The distance of any point on an ellipse from an imaginary focus is in a constant ratio to its distance from the corresponding directrix; this ratio is equal to the imaginary eccentricity of the conic.

The equation of the tangent at the extremity of the imaginary latus rectum is $x + \acute{e}y = b$.

The equation of the normal at the same point is $x - \frac{y}{\acute{e}} + b\acute{e}^2 = 0$.

The circle described on an imaginary focal radius as a diameter touches the minor auxiliary circle.

Other theorems in respect to the ellipse might be added; but enough have been given to illustrate the theory. The above list contains the most of the important propositions.

If the conic be a hyperbola, two of the foci are still real, and two imaginary; but the imaginary foci coincide in position with the real foci of the conjugate hyperbola. The theorems concerning the imaginary focal properties of the hyperbola are almost all identical with the theorems concerning the real focal properties of the conjugate hyperbola. For example, the locus of the foot of a perpendicular, from an imaginary focus on a tangent, is the minor auxiliary circle; and the locus of the foot of a perpendicular, from a real focus of the conjugate hyperbola on a

tangent to the conjugate hyperbola, is the same circle. The whole theory for the hyperbola is, therefore, at once evident, and further details may be omitted.

The above theory for the ellipse is also capable of another interpretation. We may say that the conjugate ellipse is wholly imaginary, and that the theorems in the above list give us the focal properties of the conjugate ellipse.

In the case of the parabola, the theory of the imaginary foci is more complicated. Since the line at infinity is tangent to the parabola, two of the four tangents drawn from I and J coincide, and there are left only three tangents and three points of intersection. Two of these are I and J, and the other is the real finite focus. Thus the circular points at infinity are the imaginary foci of the parobola.

It would be interesting to know what properties the points I and J have in common with the finite foci of a conic, and especially with the finite focus of a parabola; but this question I have not investigated.

NOTES ON SOME SUMMER BIRDS OF ESTES PARK, COLORADO.

BY VERNON L. KELLOGG, LAWRENCE.

Estes Park is a beautiful little valley at the base of Long's Peak, about seventy miles northwest of Denver, being in latitude 40°24′ north, longitude 105°36′ west. The Big Thompson, affluent of the North Platte, fed by the melting snow of the Front Range, of which Long's Peak and adjacent peaks are a spur, winds through the six miles of the Park's extent, and its many small tributary streams come tumbling out of the surrounding hills and mountains in well-worn gorges, or glide gently down woods-lined valleys. Spreading away from the Big Thompson on either side, for half a mile or more, extends a luxuriant pasture. The Park narrows at its head, and the bounding lateral moraines, covered with ice-worn boulders, approach rapidly, until the Park is no park, but a gorge, which cuts deeply into the great snow-covered range, and is yet as wild and primeval in its aspect and condition as before the first camp-fire smoke ever drifted up from the now fairly civilized meadows along the Big Thompson.

The altitude of the Park is about 8,000 feet, and of the range from which its massive boulders have been brought about 13,000 feet; while Long's Peak rears its square-capped head to an elevation of 14,271 feet. The peaks and chasms of the range are white with never-melting snow, and in certain places — two, at least — the snow has become so compacted, and the well-marked crevasses and half-proven movements so sure evidences, that Hallet's and Chapin's Glaciers are beginning to attract more than local attention. Great tracts on the range sides are covered with spruce forests, but so many fires have swept over the region that the hills and valleys are covered with the charred spars of spruce and pine, some standing, others prostrate and entangled in the up-springing new growth.

The following notes on the avian fauna of the Park are from observations made during the summers of 1886–1889. A brief visit in June of this year (1890) gave opportunity for some corroborative observation:

1.—Anas strepera Linn. Gadwall.

A pair seen on a small pond in an offshoot of Estes Park, called Horseshoe Park. This duck is not an uncommon summer resident.

2.—Actitis maculata (Linn.) Spotted Sandpiper.

Not uncommon. A few seen along the Big Thompson, and a pair seen August 19 at a small pond near timber-line.

3.—Colinus virginianus (Linn.) Bob-white.
A few birds were brought into the Park some years ago, and still are heard from occasionally. I was startled one morning by hearing the clear whistle of this Eastern quail, but succeeded in discovering the fact of the importation.

4.—Dendragapus obscurus (Say.) Dusky Grouse.
Common. When flushed, will alight generally in trees near at hand, and are easily shot. The birds were found in tangled gorges and on fairly open hillsides.

5.—Lagopus leucurus Swains. White-tailed Ptarmigan.
Common above timber-line. While climbing Long's Peak, I could have killed easily, with my climbing-stick, a hen and her young. At other times the birds were easily frightened. As a rule, they trust to their protective plumage coloration to save them from detection, and allow a close approach.

6.—Columba fasciata Say. Band-tailed Pigeon.
But one small flock noted.

7.—Zenaidura macroura (Linn.) Mourning Dove.
Not uncommon.

8.—Buteo borealis calurus (Cass.) Western Redtail.
One shot.

9.—Aquila chrysætos (Linn.) Golden Eagle.
A few seen. A pair were nesting in an old crater known as Specimen Mountain, near the headwaters of the Big Thompson and the Cache á la Poudre.

10.—Haliætes leucocephalus (Linn.) Bald Eagle.
One seen. A rare resident.

11.—Falco mexicanus Schleg. Prairie Falcon.
One female shot above timber-line.

12.—Falco columbarius Linn. Pigeon Hawk.
A few seen. Not an uncommon resident.

13.—Falco sparverius Linn. Pigeon Hawk.
Common. Many were seen about camp.

14.—Bubo virginianus subarcticus (Hoy.) Western Horned Owl.
One seen.

15.—Ceryle alcyon (Linn.) Belted Kingfisher.
Common along the Big Thompson.

16.—Dryobates villosus harrisii (Aud.) Harris's Woodpecker.
Common. This is an interesting bird in Estes Park, as it is not a typical harrisii, but shows in a series of specimens a greater or less departure from the true villosus. On June 10, 1890, I shot a male, of which my note-book says: "This is a typical harrisii, no white marking at all on the wing-coverts, except the faintest suspicion on one feather. The nuchal crescent unbroken, rich black on back; belly inclined to be grayish-white."

17.—Dryobates pubescens gairdnerii (Aud.) Gairdner's Woodpecker.
Not common. As in the preceding, specimens are seen which are not typical gairdnerii, but which display growing variational changes from pubescens.

18.—Picoides americanus dorsalis Baird. Alpine Three-toed Woodpecker.
Five were seen about a camp near timber-line, and in wild country. Two were shot for identification.

19.—Sphyrapicus varius nuchalis Baird. Red-naped Sapsucker.
Not common.

20.—Sphyrapicus thyroides (Cass.) Williamson's Sapsucker.
Common. Several skins of both males and females taken in June.

21.—Melanerpes erythrocephalus (Linn.) Red-headed Woodpecker.
Rare visitant. But one seen.

22.—Colaptes cafer (Gmel.) Red-shafted Flicker.
Common. No auratus seen.

23.—Phalænoptilus nuttalli (Aud.) Poor-will.
Not common.

24.—Chordeiles virginianus henreyi (Cass.) Western Nighthawk.
Common. At twilight, companies of these birds were seen on their foraging excursions.

25.—Trochilus platyceras Swains. Broad-tailed Hummingbird.
Common. These birds were met in large numbers on occasional tramps. Announcement of the proximity of a company of the hummers would be made by the "rattling" or "clacking" sound which the combined vocal efforts of the band resulted in.

26.—Tyrannus vociferans Swains. Cassin's King-bird.
Common.

27.—Otocoris alpestris arenicola Hensh. Desert Horned Lark.
Common.

28.—Pica pica hudsonica (Sab.) American Magpie.
Common. These striking birds were seen generally in small flocks frequenting the sparse thickets along the Big Thompson. They keep up a continual chattering. Young, with tails half grown, were noted during the first week in June.

29.—Cyanocitta stelleri macrolopha (Baird.) Long-crested Jay.
Abundant. One of the most prominent of the Park birds, because of its numbers, and constant harsh cries.

30.—Perisoreus canadensis capitalis (Linn.) Rocky Mountain Jay.
Common in the forests flanking the Front Range, being found quite up to timber-line. These strange, tame birds will eat the crumbs of a camp lunch at one's very feet. They appear, unheralded by cry or flapping of wings, in the spruce trees around camp, and with familiar interest take cognizance of all that is doing.

31.—Picicorvus columbianus (Wils.) Clarke's Nutcracker.
Not common. Noisy groups of these birds frequent the pine-tops.

32.—Agelaius phœniceus (Linn.) Red-winged Blackbird.
Abundant along the Big Thompson where it flows through the narrow meadows. Nest and eggs found June 21.

33.—Sturnella magna neglecta (Aud.) Western Meadow Lark.
Abundant in Big Thompson meadows. Met with above timber-line.

34.—Scolecophagus cyanocephalus (Wagle.) Brewer's Blackbird.
Abundant, especially in Big Thompson meadows.

35.—Pinicola enucleator (Linn.) Pine Grosbeak.
One male shot at camp near timber-line on the Front Range, near the headwaters of the Big Thompson and Cache á la Poudre.

36.—Loxia curvirostra stricklandia Ridg. Mexican Crossbill.
One small flock seen, out of which a male and female were shot.

37.—Leucosticte australis (Allen.) Brown-capped Leucosticte.
A few of these interesting birds were seen on the summits of the Front Range peaks (12,000 to 13,000 feet alt.). Insects which had fallen upon the snow were snatched up by the birds. Those seen were not very wild, and often whisked close by me. I saw a pair of the birds while I was eating lunch on the summit of Long's Peak (14,271 ft.).

38.—Zonotrichia leucophrys (Forst.) White-crowned Sparrow.
Common.

39.—Zonotrichia intermedia Ridgw. Intermediate Sparrow.
This interesting form was common in the low bushes and thickets just above timber-line on the range. I noted these birds in abundance on a mountain tramp along the range for ten miles, August 10, and on the return tramp, August 19.

40.—Spizella pallida (Swains.) Clay-colored Sparrow.
One shot August 10.

41.—Junco hyemalis (Linn.) Slate-colored Junco.
Not common. Found mostly about timber-line. Found nesting June 14, 1886. The identification of this Junco is not positive.

42.—Pipilio chlorurus (Towns.) Green-tailed Towhee.
Common.

43.—Piranga ludoviciana (Wils.) Louisiana Tanager.
Common. This beautiful bird is one of the first noted by casual sight-seers in the Park.

44.—Petrochelidon lunifrons (Say.) Cliff Swallow.
Common.

45.—Tachycincta thalassina (Swains.) Violet-green Swallow.
Abundant.

46.—Vireo gilvus (Viell.) Warbling Vireo.
Only a few seen, but doubtless common.

47.—Dendroica audubonnii (Towns.) Audubon's Warbler.
Not uncommon. One shot in a dense spruce forest.

48.—Cinclus mexicanus Swains. American Dipper.
Not uncommon. This interesting bird stands with half the body submerged and with footing most precarious in the swiftest-running portions of the mountain streams.

49.—Salpinctus obsoletus (Say.) Rock Wren.
Not uncommon. A noisy, dull-colored little bird, frequenting rough mountain sides.

50.—Troglodytes ædon parkmanni (Aud.) Parkmann's Wren.
Common. The young seen.

51.—Certhia familiaris americana (Bonap.) Brown Creeper.
Apparently rare, but four being seen. Met with at timber-line.

52.—Sitta carolinensis Lath. White-breasted Nuthatch.
Not uncommon in heavy woods.

53.—Sitta carolinensis aculeata (Cass.) Slender-billed Nuthatch.
Not uncommon.

54.—Sitta pygmæa Vig. Pygmy Nuthatch.
But one seen.

55.—Parus atricapillus septentrionalis (Harris.) Long-tailed Chickadee.
Common.

56.—Parus gambeli (Ridgw.) Mountain Chickadee.
Common. One typical specimen taken. Others seen.

57.—Myadestes townsendii (Aud.) Townsend's Solitaire.
Rare; but one specimen obtained.

58.—Turdus aonalaschkæ audubonii (Baird.) Audubon's Hermit Thrush.
Not uncommon. The sweet song of this thrush breaking in upon the stifling silence of the dense spruce forests was rendered doubly sweet by the circumstances. It seemed far superior to any other thrush song I have heard.

59.—Merula migratoria propinqua Ridgw. Western Robin.
Abundant. Some of the specimens taken were faded, but others were nearly as well colored as specimens from eastern Kansas. Met with at timber-line.

60.—Sialia arctica (Swains.) Mountain Bluebird.
Abundant.

The following notes on the summer birds of the Park are given on the authority of Mr. Gilbert Pierce, formerly of Lamb's Ranch, Estes Park:

61.—Æchmophorus occidentalis (Lawr.) Western Grebe.
Rare, one seen.

62.—Anas boschas Linn. Mallard.
A common summer resident.

63.—Anas carolinensis Gmelin. Green-wing Teal.
Common summer resident.

64.—Archibuteo ferrugineus (Licht.) Ferrugineus Roughleg.
Common resident.

65.—Falco perigrinus anatum (Bonap.) Duck Hawk.
Rare; one seen in June.

66.—Megascops asio maxwelliæ (Ridgw.) Rocky Mountain Screech Owl.
Rare visitant.

67.—Glaucidium groma Wagl. Pygmy Owl.
Resident, rare.

68.—Tyrannus verticalis Say. Arkansas Kingbird.
Summer resident, rare.

69.—Contopus richardsonii (Swains.) Western Wood Pewee.
Common resident.

70.—Empidonax difficilis Baird. Baird's Flycatcher.
Common resident.

71.—Empidonax obscurus Swains. Wright's Flycatcher.
Summer resident, not uncommon.

72.—Corvus corax sinuatus (Wagl.) American Raven.
Occasional visitant.

73.—Icterus bullocki (Swains.) Bullock's Oriole.
Occasional visitant.

74.—Junco canicops (Woodh.) Gray-headed Junco.
Common resident at timber-line.

75.—Melospiza fasciata montana Hensh. Mountain Song Sparrow.
Summer resident; not uncommon.

76.—Vireo solitarius plumbeus (Coues.) Plumbeus Vireo.
Common summer resident.

THE CIVILIZATION OF THE MOUND-BUILDER.

BY H. C. FELLOW, TONGANOXIE.

That we may discuss this subject systematically, let us ask ourselves three questions, and answer them in the same order—*i. e.:* (1) What is civilization? (2) Who were the Mound-Builders? (3) How and to what extent could they lay claim to a civilization?

First: Civilization expresses the notion of progress, and embraces the ideas of the "melioration of the social system, as well as the expansion of the mind and faculties." Its meaning is broad, and implies: 1. Increased knowledge; 2. A chang-

ing of belief; 3. (*a*) A development in Art, (*b*) in Morals, (*c*) in Law, and (*d*) in Custom.

These are manifestations of a development to be seen in man as he passes through the various stages of savagery, barbarism, and enlightenment.

Civilization is the resultant of causes which may be classified and discussed as follows:

(1) The natural environments.

(2) The cultivation of a desire of means for the support of life.

(3) The cultivation of a desire for increased physical prowess and skill.

(4) The cultivation of a desire for intellectual improvement.

(5) The cultivation of a desire for spiritual happiness.

If these desires have been awakened within the human breast, followed by an activity of the various powers to attain the desired end, then there has been progress in the process of becoming civilized, and there will necessarily follow the implied results as given in the definition.

If the fact that traces of an awakening and development of the physical, intellectual, and moral forces can be found and proven by archæological research, then we may justly lay claim to a civilization for the prehistoric American Mound-Builder.

In reference to who these people were, we can only say that they composed a confederation which occupied the southern half of the North-American continent previous to the Indian invasion. Their origin is a subject of controversy and conjecture, and can only be based upon a comparative study of their monuments with those of the surrounding, and, perhaps, kindred nations.

Many people suppose that they were the ancestors of the Indians, and possessed no higher state of civilization, when in fact no such knowledge could be gained from the aborigines by early explorers.

It is said that the "Choctaws and Chicasaws, who at one time occupied a part of southwest Tennessee and northern Mississippi, do not claim the hundreds of well-built mounds along the Mississippi river to be the work of their ancestors, and, in fact, could throw no light upon their history."

In talking with Bundy, war chief of the Miamis, on the Wabash, he told me that the manufacture of stone and flint implements must not be attributed to the Indians; but that, upon finding them, his people simply adopted the use of them.

The third and most important question to be considered is "How, and to what extent, can the Mound-Builders lay claim to a civilization?"

(1) Have natural environments affected them?

Buckle champions the philosophy that these have been the great forces that have wrought the civilization of the world, and that intellectual and social development are but products of that onward progress.

He claims that, during this remote period, only the people dwelling within the limits of the torrid zone really possessed any degree of civilization; that those in America, dwelling north of the 20th parallel, were wholly incapable of making much progress in the arts of life, or organizing itself into a fixed and permanent society; "and that here civilization could find no resting-place."

That we may better determine the value of this dogmatic assertion, we must take into account the fact that Buckle wrote his "History of Civilization" many years before the American field of Archæology had been explored to any great extent.

All of the later standard authors, as well as the Government reports, point clearly to the fact of a prehistoric civilization for the Mound-Builder.

Because the Aztecs and Peruvians were civilized, it does not preclude evidence that their ancestors, or brethren, possessed the same boon to some degree.

I can agree thus far with Mr. Buckle, that natural environments *aid* in civilizing a people.

We see a great people scattered throughout the territory now embraced within that of the United States, locating the seat of its theocratic government at the confluence of the Ohio and Missouri with the Mississippi. The greater number settled in the Mississippi valley, and along some of the larger tributaries.

These water-ways furnished easy access to all parts of the empire, and were of vast commercial advantage to the seat of government.

In building their fortifications upon the hills, or mounds, along the Ohio and Miami rivers, I have noticed that they never neglected to build their walls *high* at places easy of approach, and *lower* along the edge of an abrupt precipice.

These clearly show that they took advantage of circumstances, and in turn were aided in becoming a commercial and a military people.

(2) Do we find any evidences that will justify us in stating that the Mound Builder cultivated a desire for means for the support of life?

(*a*) The great number of flint arrow-points, spear-heads, knives, scrapers, shell fish-hooks, celts and axes, which they manufactured, must have been used in securing and preparing food. They used their copper needles in sewing, or weaving cloth, while their corn-grinders, water-jugs, and cooking stones, tell us that their makers knew the value of properly prepared food.

(*b*) Did they seek a livelihood by commerce and trade?

Upon this point authors agree, inasmuch as their mounds are most numerous along watercourses, and especially near the confluence of rivers, that these must have been used as the best means for commercial intercourse.

Nadailac in his "Prehistoric America," says that "in the region around Greenwood, Tenn., they had advanced so far in civilization that their pottery and ornaments were truly artistic, and that they used copper and shell implements. Seven perforated pearls were found in the grave of a child."

Since copper had to be obtained from the lake region, and shells and pearls from the sea-shore, there must necessarily have been commercial intercourse between this inland people with those both north and south of them.

Sir John Lubbock, having observed large numbers of the same kind of implements in certain localities, states "that a division of labor for subsistence must have already begun," and that in the line of manufactures "pipe-carving was no doubt a profession."

These movements gave a stimulus to the spirit of trade, and in turn increased the means of livelihood.

(3) Do you find any evidence that the Mound-Builder sought to make a living by following agriculture?

Mr. Lapham, as a result of his investigations in Wisconsin, states that he has found traces of an earlier and more systematic method of cultivation than that employed by the Indians. These traces "consist of low parallel ridges as if the corn had been planted in drills. They average four feet in width, twenty-five of them having been counted in the space of one hundred feet; and the depth of the walk between them is about six inches. These appearances, which are here denominated ancient garden-beds, indicate an earlier and more perfect system of cultivation than that which now prevails; for the present Indians do not appear to possess the ideas of taste and order necessary to enable them to arrange objects in consecutive rows. Traces of this kind of cultivation, though not very abundant, are found in

several parts of the State. The garden beds are of various sizes, covering generally from twenty to one hundred acres. As a general fact they exist in the richest soil as it is found in the prairies and burr-oak plains. In the latter case, trees of the largest kind are scattered over them."

This last statement is sufficient to dispel the thought of attributing such to the early white settlers. Upon the whole, Mr. Lapham's statements reflect in a clear light the Mound-Builder's view of the value of systematic cultivation of the soil.

(4) The third cause that led to the civilization of this people was a seeking to gratify a desire for physical prowess and skill.

As in the neighborhood of the lakes it was largely a mining, manufacturing, and agricultural State, so we find the center of a great military State in Ohio and Indiana.

Nadailac, in his "Prehistoric America," says that "besides 250 fortifications in New York, there have been discovered 10,000 mounds in Ohio, of which 1,500 were military defenses. The importance and greatness of the work is a proof of an organized system of labor, of an organized community, and a powerful hierarchy."

The "Prehistoric Times" states that these mounds "indicate a population both large and stationary"; and according to Mr. Davis "there was not in the sixteenth century a single tribe of Indians (north of the semi-civilized nations) between the Atlantic and the Pacific which had means of subsistence sufficient to enable them to apply, for such purposes, the unproductive labor necessary for the work; nor was there any in such a social state as to compel the labor of the people to be thus applied."

This leaves us to infer that there was a stability in their social organization equal to that found among other civilized nations of that time.

Squier states that "he has reasons to believe that there was a line of fortifications and signal stations extending from the Susquehanna in New York to the source of the Alleghany, and thence diagonally across Ohio and Indiana to the Wabash river;" also that "there was a line along the Big Harpeth river, in Tennessee."

The object of such military lines of defense was doubtless to serve as a protection against the early Indian invaders who came down from the North.

General Harrison, in speaking to the Historical Society of Ohio, said that the mounds which he had examined in that State "have a military character stamped upon them which cannot be mistaken."

I here give a few facts concerning one of the most interesting that I have examined.

Fort Ancient, Ohio, is situated on the left bank of the Little Miami, forty-two miles above Cincinnati. It is an irregularly-shaped artificial mound, 230 feet high, and contains some 628,000 cubic yards of earth. The summit is truncated, and bounded by an inclosing ridge four miles in length, some twenty feet high at accessible points, and from four to five feet high where the side of the mound is precipitous.

This, with hundreds of others, was garrisoned by thousands of the bravest of the empire, who with bows and arrows, bolas and boulders, withstood the shock of the oncoming savage, till, swept before the tornado, they left burning their signal-fires, their relics and monuments, as foot-prints in the path of civilization.

As proof that they sought to become skilled in their various vocations, they at first used rough stones as implements, and afterwards gratified their inventive and artistic tastes by polishing and sharpening them. The celt, to be useful in dressing skins, they sharpened at one end; they sharpened the ax, and made a depression around the pole for the handle. They made their arrow-points according to certain patterns, so they could be fastened securely to the shaft, and give a whirling

motion to the arrow as it passed through the air. Their thong-sizers, plummets, saws, needles, pipes, and decorated pottery, all bear evidence that the Mound-Builder eagerly sought to become skilled.

In comparison with the rudeness of the Celtic art, Sir John Lubbock says: "Very different was the condition of American art. The art of pottery attained a considerable degree of perfection. Some of the vases found in the tumuli are said to rival in elegance of model, delicacy and finish, the best Peruvian specimens."

The skill that they have shown in the construction of many of their inclosures is even more remarkable. In Pike county, Pa., is to be found an exact square, surrounded by a perfect circle. There are, near Portsmouth, four perfectly constructed concentric circles, intersected by avenues or walks exactly true to the cardinal points. Near where the Root river empties into the Mississippi, there is an interesting inclosure, the principal mound being a cone, the circumference of whose base is 36 feet, and whose altitude is 12 feet. This is situated within the center of a circle. Without this circle are three bounding ridges, forming the three sides of a triangle. Each ridge is 144 feet in length, 12 feet across at the base, and are respectively three, four, and five feet in height, or together equal that of the central mound. These, certainly, are manifestations of a mathematical skill.

The evidence of their having manifested a desire for intellectual improvement is not so strong as other things pointing backward to some of the other causes of their civilization; yet we have sufficient traces, we think, to warrant us in stating that they sought to develop intellectually.

Some authors claim that certain mystical writing-tablets have been found in the mounds, but the authenticity of such is doubted. From personal observation of a tablet now in the Welch Museum, at Wilmington, Ohio, I find that some of the characters are very much like Greek letters. Prof. Collett, State Geologist of Indiana, stated to me that he regarded it as spurious. On the other hand, Prof. Blake, of the Kansas State University, who succeeded in taking a cast, under water, of the celebrated Dighton rock, while he was yet quite young, told me that the Danish archæologists did not regard the characters upon it as Norse, but rather of Mound-Builder origin. Hence we consider that this throws the weight of evidence in favor of the Mound-Builders' use of characters or letters in the expression of thought.

The picture-writing and construction of animal mounds point to the fact that many of this people must have been close students of natural history. "The art of picture-writing they shared with the Aztecs and Inipa of the Peruvians."

As I have stated concerning their skill in constructing their fortifications in perfect squares, triangles, and circles, it is quite reasonable that we infer from such that many were students of some system of mathematical science.

It is thought that these few statements will be sufficient to indicate that there was some intellectual development.

(5) The fifth and greatest cause that has aided in the civilization of man has been the development of his ethical and religious nature; and the question that we are led to ask ourselves is: Have we found any evidences that the Mound-Builder had and exercised such a nature? That we may answer this question the more definitely, let us examine some of their sacred mounds.

The temple of the Aztecs was called by them a teocallis. They built it upon a truncated pyramid, and here worshiped God, whom they called Theut, or Theot. That this word bears a strong resemblance to the Greek word Thos, everyone can readily see; and as to their relationship, that is a problem for the philologist.

If we find a similarity in the structure of the Mound-Builder and Aztec temple, might we not at least draw a slight inference that their religious systems were somewhat alike?

One of the largest temple mounds in the Mississippi valley is to be seen in Illinois, not far from the mouth of the Missouri river.

It is a truncated pyramid, 500x700 feet at the base, and has an altitude of 90 feet. The summit has a surface of 200x450 feet. Upon this platform is a small, conical mound, which, upon excavation, yielded a large number of bones, funeral vases and stone implements. This, most probably, was an altar upon which the great high priest of the nation offered up human sacrifices and gifts to their gods. Near by are four elevated platforms from 250 to 300 feet across. Beneath the surface of these have been found a large number of relics, most probably votive offerings of the worshipers.

This people must have been polytheistic in religious belief. The numerous crescent-shaped stones insignia and mounds indicate a worship of the moon, while the hundreds of effigy monuments point to a worship of animals. Of these, the most celebrated one is the great serpent mound, in Adams county, Ohio, now a detached part of the Archæological collection of Harvard University. It consists of an undulating ridge nearly 1,000 feet in length, 30 feet across midway between the head and tail, and averages five feet in height.

Within its open mouth rests "an embankment of earth, without any perceptible opening, four feet in height, and is perfectly regular in outline, its transverse and conjugate diameters being one hundred and sixty, and eighty feet respectively." Surely, if they worshiped animals, they could not refrain from praying to this wonderful inanimate monster.

As their religious natures were strengthened by their systematic devotions to their deities, so they must have exercised their ethical natures by burying gifts with the dead.

Hundreds of burial mounds have been found, containing human bones surrounded by copper and shell ornaments, pieces of delicately-wrought burial urns, pipes, implements, and coarse cloth. These were tokens of veneration, and probably designed for the use of the deceased in a future state. In some parts cremation was practiced, while in others it was most probably thought to be morally wrong, and so the dead were buried in well-constructed stone cists or coffins.

We have seen that they were prompted by the circumstances and desires, which, employed, result in a civilization; that they advanced in knowledge beyond the state of savagery to the highest stage of barbarism, cannot be gainsaid; that their systems of military tactics, of the division of labor and industries, and of priestcraft, were well developed, will not be denied; that they must have had ideas of the melioration of their social system, and expansion of the mind and faculties, which, employed, embrace the notion of progress. Therefore our predecessor, the Mound-Builder, must have possessed a prehistoric civilization of a high order.

ON THE SUGARS OF WATERMELONS.

[Preliminary note.]

BY J. T. WILLARD.

In view of the striking sweetness of watermelons, it seems a little remarkable that there are no analyses recorded in any of the compilations accessible to the writer. Several samples have therefore been examined, and the results are of such interest that the subject will be further studied another year.

The juice was obtained by squeezing the ripe pulp in a cloth bag. The reducing sugars present were determined by the ordinary volumetric method, using Violette's

modification of Fehling's solution. Upon defecating the juice by means of basic lead acetate, and examining the solution with the saccharimeter, it was found that it possessed only slight optical activity, and was sometimes dextro-rotatory, sometimes lævo-rotatory. It was obvious that there was present some substance other than cane sugar, which affected the polarized ray, and nearly balanced the rotation produced by the cane sugar. The cane sugar was therefore determined by the chemical method; *i. e.*, by inversion and titration with the copper liquor, correction being made for the reducing sugars originally present. In some cases the cane sugar was also determined by Clerget's method. In this, the polarization of the juice before and after inversion gives the necessary data for calculating the percentage of cane sugar. The results obtained by these methods on the four samples analyzed are given below:

ANALYSES OF WATERMELON JUICE.

DATE.	CANE SUGAR.		*Total reducing sugars.*	*Specific gravity.*
	Clerget's method.	*Method by inversion.*		
September 17	.....	2.39	4.03	1.033
September 18	3.43	3.01	4.18	1.032
September 23	3.31	3.11	3.46	1.031
September 26	3.32	3.12	3.11	1.030

The optical results indicating the presence of levulose, it seemed desirable to determine the amount of this sugar present. This was accomplished by destroying the levulose by Sieben's method as described by Wiechmann in the Journal of Analytical Chemistry, vol. IV, p. 257.

A considerable amount of the juice obtained September 26th had been preserved by adding five per cent. of lead solution to it. On October 30th it was analyzed again as before, and in addition a determination of levulose was made. For this purpose some of the juice was freed from lead by adding sodium sulphate, and diluted so as to contain about 2½ per cent. of sugar. To 100 cc. of this, 60 cc. of six times normal hydrochloric acid were added, and the whole heated on the boiling-water bath for three hours. By this means levulose is said to be entirely decomposed while dextrose remains unaltered. After neutralizing the acid and filtering, a determination of the reducing sugar left will give the dextrose originally present in the juice, plus that resulting from the inversion of the cane sugar. Having determined the total reducing sugars in the original juice and in the inverted juice, it will be seen that we possess the necessary data for calculating the amount of levulose and of dextrose present in the original juice. The result was as follows:

Cane sugar, by Clerget's method, 3.30 per cent.; chemical method, 3.27 per cent.; total reducing sugars, 3.14 per cent.; glucose or dextrose, .69 per cent.; levulose, 2.45 per cent.

The large percentage of levulose present is a very interesting fact. The author hopes to study the subject more fully another season, and to confirm his assumption that the lævo-rotatory sugar found is *levulose*. The sugar has at least these properties of levulose, viz.: A very sweet taste; a strong lævo-rotation; a reducing action on copper solution; and is destroyed by the hydrolytic action of hydrochloric acid.

NOTES ON SOME KANSAS SALT MARSHES.

BY ROBERT HAY, JUNCTION CITY.

It is well known that in the ages before settlement, the wild animals of the plains —the deer, the bison, the antelope—had their places where they obtained salt These were known as *licks*, and, joined to the name of some animal, or to some epithet more or less descriptive, this word becomes a proper name. In these licks the saline matter was held in earths of various kinds—clays, and shales, and sandy alluvia; but not infrequently there were connected with them salt springs, from which hunters and early ranchmen obtained salt by evaporation.

Kansas has a fair proportion of these salt springs of the plains, and the National Government made over to the State sundry sections of land on which they were located, supposing that they were giving title to valuable mineral deposits. Some of these became part of the endowment of the State Normal College, at Emporia, but the prices for which they have been sold have not exceeded that of agricultural lands in the same regions.

Some of these licks, with or without springs, are *salt marshes* of considerable extent, at the lower end of which, streams that pass through them, or originate on them, are more or less saline in character. The Saline river has its name from this circumstance. There are salt marshes—

1. In Cowley and Sumner counties, at and northwest of Geuda Springs.
2. In Stafford county, with a salt stream running into Reno county.
3. On Rattlesnake creek, in the north of Lincoln county.
4. On Salt creek, in Mitchell county.
5. On Plum creek, northeast of Beloit.
6. On Marsh creek, and Little Marsh creek, northwest and northeast of Jamestown, in Cloud county.
7. On a small tributary of the Republican, in Republic county, northeast of Concordia.

Besides these, there are the salt pool of Meade county, salt springs in the Saline valley, and the salt plains of the Cimmaron, just outside the State. The first has been described by the present writer in an article published by the State Board of Agriculture.

No. 7 in the above list of salt marshes is the Tuthill marsh described by Prof. Mudge, as State Geologist, a quarter of a century ago. As a barren salt marsh it is now much less in area than when our old friend was there, the alluvia from the plowed land of the district having washed over it, and allowed vegetation—typhaceæ, and other marsh plants—to obtain a firm hold.

The geology of the formations which furnish the salt to most of these areas has become plain to the writer through recent investigations. The salt marshes near Geuda Springs are related to shales which are at the top of the Permo-Carboniferous deposits of the region, or at the beginning of what I have elsewhere called the saliferous horizon, of which the great salt-rock deposits of Kingman, Reno and Ellsworth counties are the best-known exponents. Wellington is the place nearest to Geuda where the salt rock has been exploited. Near Geuda there is also a fine bed of saccharoidal gypsum. The position of the Cowley county salt marshes, in relation both to the gypsum and the rock salt, suggested that the salt marshes of Republic, Cloud, and Mitchell counties had some such relation to the gypsum of Marshall county and the rock salt of Ellsworth and Kanopolis. Visits to the regions indicated removed all ground for this idea, and revealed the true position of the marshes, showing that they all get their salt from shales of the Dakota period. The

saccharoidal gypsum of Marshall county, outcropping on the banks of the Big and Little Blue, a few miles above Blue Rapids, is fully 250 feet lower in the geological scale than the gypsum near Geuda, and corresponds with an horizon of gypsiferous shales in the Permo-Carboniferous beds which are just below the lowest strata that outcrop in the railway cut at Fort Riley.

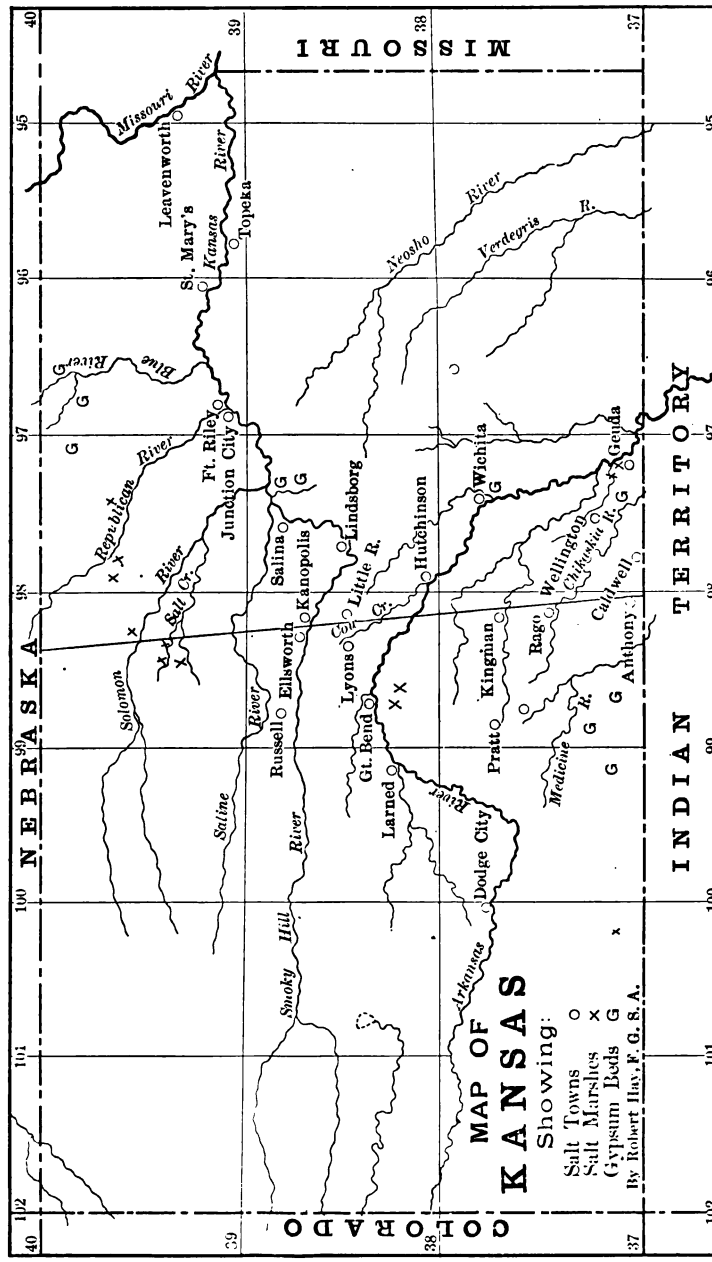
The largest of the northern salt marshes, and probably the largest in the State, is the one on Marsh creek (No. 6 in the list). Its lowest part is in section 4, town 5, range 5, W., and it has more than half of section 5, and stretches into three sections of town 4, and into some part of range 6. It is seven miles long, and in one place it is quite a mile across. Like the Tuthill marsh, its area has been reduced since the settlement of the region, and from the same cause, but its large areas of saline efflorescence, resembling snow-covered fields, are remarkable objects in the extensive views obtained from neighboring uplands. The marsh itself is below the level of the alluvial bottom. In places the alluvia form steep walls of 10 to 15 feet high, bounding the lower saline slopes, but elsewhere the alluvia have all been washed away, and the marsh slopes up to thin, sedimentary soils, formed of the shales and harder beds that constitute the geological bed-rock, and from which the marsh derives its salt. These shales are at the top of the Dakota formations, and wells sunk just outside the marsh, at higher levels, penetrate the highest Dakota sandstones, and these are seen in outcrop only a mile to the south. On the N.W.¼ of section 5, town 5, range 5, some years ago, a well was bored fifty feet deep within the borders of the marsh. It gave an artesian flow of brine, which, though partially choked, is still running. Its strength on the salimeter was 14°, which is exactly the strength of brine taken from a hole six feet deep on the Tuthill marsh the day before. It was believed by the well-borers that a stream of fresh water diluted this flow of brine. The tops of the slopes, on all sides of the marsh, are crowned with the Benton limestones. Wells near by penetrate black shale, the analogue of the lignite bed of the upper Dakota, which, near Tuthill marsh and other places of the region, is worked for fuel. The bed of the marsh, in wet seasons, is a dangerous black bog. At the dry time of our visit it was safe, but soft to the foot.

There are two marshes on Salt creek, in Mitchell county (No. 4 of the list), differing little from the one just described, except that in both, the alluvia, forming

FIG. IV. Section on a branch of Salt Creek, Mitchell Co., Kas.

vertical walls to the creek and marsh, are much thicker, being 15 to 20 feet in thickness; and in the larger marsh there are two vertical outcrops of Dakota sandstones, *in* one of which is a salt spring, and Benton shales are exposed at less than 25 feet above the highest exposure of Dakota formations.

In no essential particulars do any of the marshes (3 to 7 in the list, inclusive), eight in all, differ from the descriptions already given. The salt is in each case derived from shales of the Upper Dakota, so there is no connection with the salt-rock horizon which came at, or just after, the close of the Permo-Carboniferous period.


MAP OF KANSAS
Showing:
Salt Towns o
Salt Marshes x x
Gypsum Beds G
By Robert Hay, F. G. S. A.
NEBRASKA
MISSOURI
COLORADO
INDIAN TERRITORY
Missouri River
Leavenworth
St. Mary's
Kansas River
Topeka
Blue River
Ft. Riley
Junction City
Republican River
Salt Cr.
Solomon River
Saline River
Smoky Hill River
Salina
Kanopolis
Ellsworth
Russell
Lindsborg
Little R.
Cow Cr.
Lyons
Gt. Bend
Larned
Hutchinson
Wichita
Neosho River
Verdegris R.
Chikaskia R.
Wellington
Caldwell
Geuda
Anthony
Kingman
Rago
Pratt
Medicine R.
Dodge City
Arkansas River

The writer has visited a salt marsh near Lincoln, Nebraska, which is also supplied from Dakota shales, which Prof. Hicks, the State Geologist, informs me belong to the middle of the series; and he also says that salt recently found by the drill at Hastings is at the bottom of the Dakota. It appears, then, that the Dakota must be added to the number of those rock series that are rightly termed saliferous. Perhaps the fact that the Dakota lignite and the Dakota dicotyledonous leaves indicate much land near marine deposits might have led us to infer shallow marine waters and possible salt deposits. The actual recognition of the salt shales justifies such inference, and is another fact in the physiography of the Dakota time. Possibly salt licks and salt marshes in other parts of the plains region may hereafter be recognized as belonging to the same Dakota horizon.

The plate and figure are from a longer article, on the "Geology of Kansas Salt," in the Seventh Biennial Report of the State Board of Agriculture.

ON THE STRUCTURE OF THE KANSAS CHALK.

BY S. W. WILLISTON.

In January, 1882, Mr. (now Dr.) W. S. Bunn, a student of Kansas University, published in the Lawrence (Kans.) *Home Journal*, a brief notice of organic remains occurring in the Kansas chalk. The means at his command did not enable him to clearly discern the objects, but his description renders it certain that he had detected coccoliths, though mistaken in his supposition as to their nature and origin.

That the chalk should be structureless, as had been previously believed by Professor Patrick, was hardly to be expected, and an examination confirms Dr. Bunn's statement of the organic origin of the material. That I did not give Dr. Bunn credit for first recognizing its organic nature, in a notice recently published by me in *Science*, is due to the fact that I have only become cognizant of his communication at the present writing.

The deposit seems wholly formed of coccoliths, rhabdoliths, and foraminifera, with, perhaps, radiolarians and sponges. The coccoliths exist as complete, or broken oval, or circular bodies from $\frac{1}{3500}$ to $\frac{1}{4500}$ of an inch in diameter, with from one to six depressions, or nuclei; the rhabdoliths as slender spicules, rarely attached to a central mass, or as rarely with a trumpet-shaped extremity. In addition there are other, less slender rods, from $\frac{1}{1000}$ to $\frac{1}{2000}$ of an inch in length, that *may* be radiolarian spicules. I have recognized at least a dozen forms of foraminifera, the one most common and conspicuous very similar to, if not identical with, a *Textilaria* of the English chalk.

A ready method of examining the material is to allow a thin film held in suspension in water to dry upon a slide, afterward mounting in balsam.

To obtain the heavier foraminifera, successive portions should be decanted from the vessel containing the powdered chalk disseminated in water, using the residue for examination.

In view of the foregoing facts, it seems to be time that the assertions of some of our leading text-books (*e. g.*, Winchell, Geological Studies, p. 433, and Leconte, Elements, p. 473) that there is no chalk in America, should be corrected.

"FEATHER ALUM" FROM COLORADO.

BY E. H. S. BAILEY, LAWRENCE.

[*Abstract.*]

This mineral, properly called Halotrichite, is rare in this country. The specimens described were received for identification from F. J. Crippen, Esq., of Denver, and came from Pitkin county, Colo. The mineral is of a silky luster, nearly white, quite soft, and soluble in water. It consists of minute capillary crystals, arranged in parallel bundles. A complete analysis of the mineral shows that it consists essentially of ferrous sulphate and alumina sulphate. It contains about 44 per cent. of water, and 33 per cent. of this is driven off below 100° C.

SELECTIVE POWER OF THE SENSE OF TASTE.

[Preliminary announcement.]

BY E. H. S. BAILEY.

The object of this work is to ascertain to what extent the sense of taste can distinguish several substances when mixed together in the same solution. For this purpose a mixture was made containing a bitter, sweet, salt and sour substance, all of the same "delicacy strength." This has been ascertained by a series of experiments previously made, and published in *Science*, vol. XI. The tests thus far made seem to show that in such a mixture the acid taste overcomes all others. These tests, however, will be carried further, and others made upon the location of the organs of taste for each substance, and upon the order in which the substances are identified in the mixture.

NOTE ON THE DISTRIBUTION AND RAVAGES OF THE HACKBERRY BRANCH KNOT.

BY W. A. KELLERMAN, PH. D.

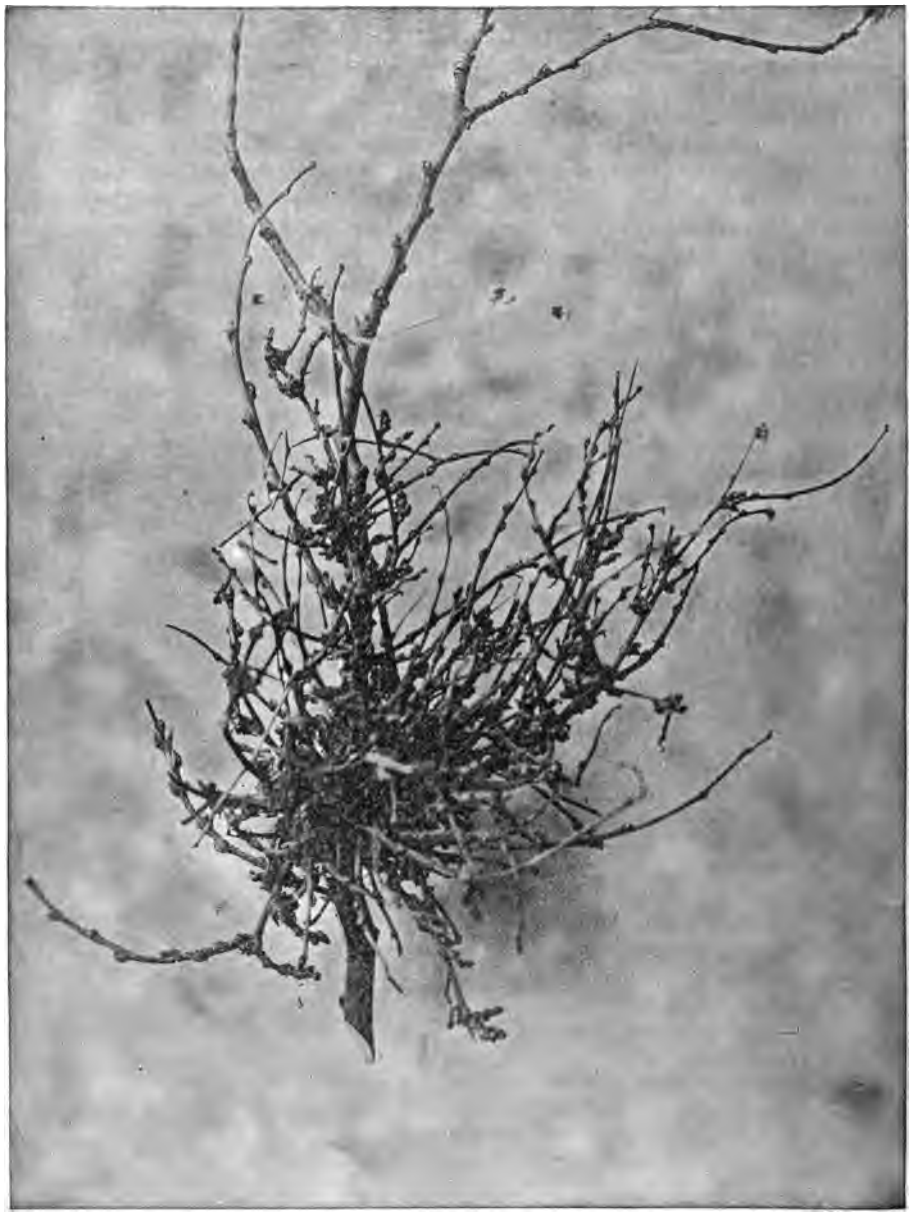
A full account of the branch knot occurring on hackberry (*Celtis occidentalis*) was given in the First Annual Report of the Kansas Experiment Station, for the year 1888, pp. 302–315.

It was shown that the knot was caused by a gall mite (*Phytoptus* sp.?), or by this insect and a fungus. The latter proved to be a new species, and was described in the *Journal of Mycology*, vol. IV. (1888), p. 93, under the name *Sphærotheca phytoptophila*, Kell. & Swing.

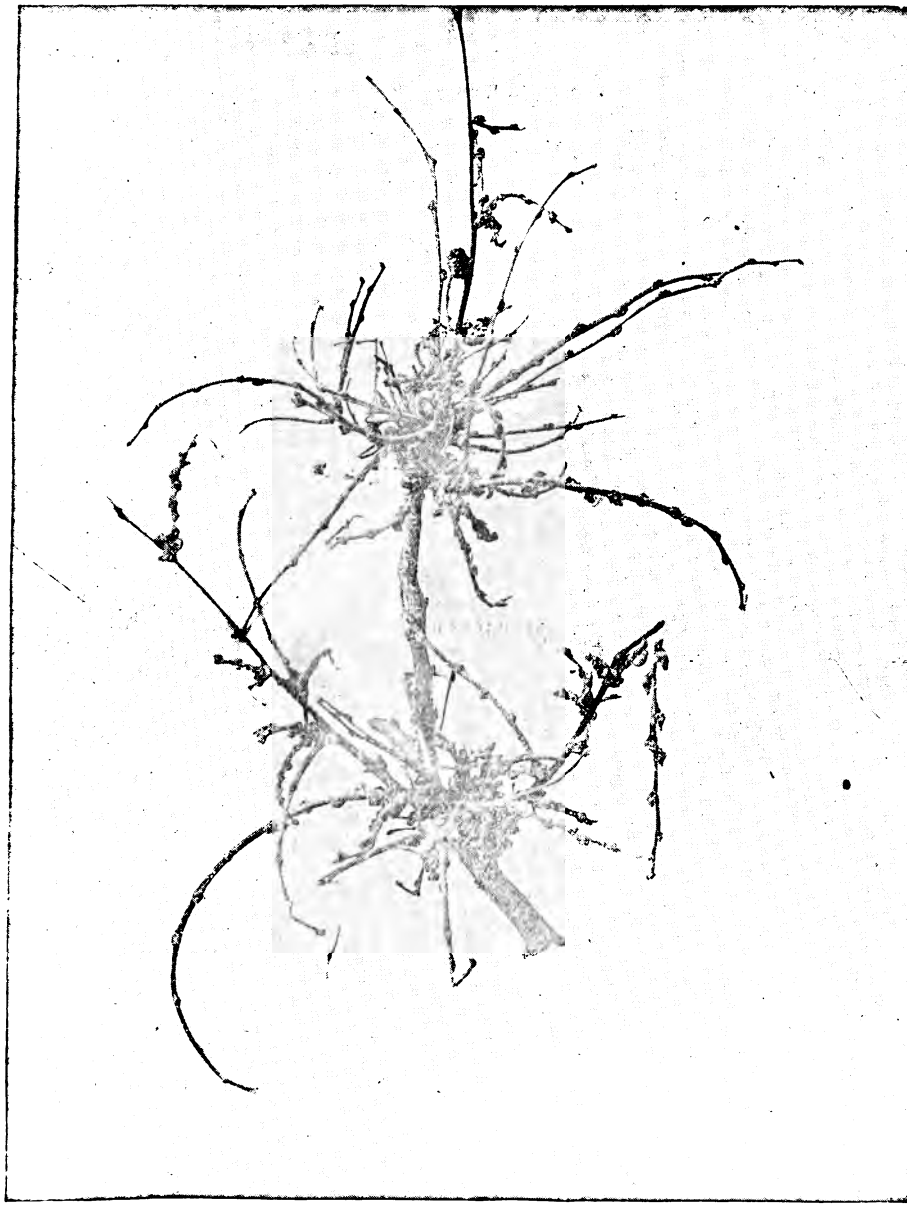
When the report above referred to was published, the knot had been reported in Brown, Riley, Clay, and Saline counties, Kansas. Its occurrence beyond the limits of our State was not then known to the authors.

The counties of Kansas where it is now known to occur are as follows:

Labette; specimens collected by Arthur Cranston.
Miami; specimens seen by the writer.
Brown; collected by J. S. Hazen.
Douglas; collected by the writer.
Shawnee; collected by the writer.
Lyon; seen by the writer.
Riley; observed several years ago.
Clay; reported by S. C. Mason.
Sumner; seen by the writer.
Saline; reported by S. C. Mason.
Rooks; reported by E. Bartholomew.



[*From Photograph.*] HACKBERRY KNOT.



[*From Photograph.*] HACKBERRY KNOT.

The above shows that the hackberry knot occurs in the extreme eastern portion of the State, and extends westward nearly or quite as far as the forest vegetation occurs.

It has been reported by Geo. F. Ingram as occurring in Texas.

Prof. Halsted reports it at Ames, Iowa. (See *Journal of Mycology*, vol. V [1889], p. 85.)

It occurs, according to W. E. Castle, very abundantly in central Ohio (Licking county).

The statement in the First Annual Report, Kansas Experiment Station, p. 302, that the trees "in the dense forest woods are seldom attacked," needs, perhaps, slight modification. In numerous cases the knots have been observed, often in great abundance, in the native forests along the various streams of water in the vicinity of Manhattan.

Isolated trees are often badly attacked and soon very much disfigured. The knots, when noticed on trees planted in streets or yards for shade or ornament, should be promptly removed and burned.

The plates here reprinted are made from photographs of branches with knots, and show their usual appearance.

THE RELATIVE SWEETNESS OF DIFFERENT ALCOHOLS.

BY EDWIN E. SLOSSON, LAWRENCE.

The present investigation was undertaken to ascertain if there is any relation between the taste of organic compounds and their chemical composition. It was thought that sweetness would be the best to experiment with, on account of its simplicity and the homologous series of sweet compounds that could be obtained. Two homologous series of alcohols were chosen, and dilute solutions of each compound prepared, ranging from two per cent. to one-tenth per cent. These were put into bottles of the same form, and several bottles of pure water added. A number of persons were then asked to taste these solutions and pick out those that were sweets, paying no attention to any other taste. In order to avoid complication with the sense of smell, the tasters were required to stop the nose. By this precaution, the spirituous taste, or rather smell, and the empyreumatic odor of methyl alcohol, were almost entirely avoided. Many persons, however, were prevented from detecting any sweetness in propyl and butyl alcohols by the bitter and acid-like tastes. The sense of taste differs widely with different people, some being able to detect sweetness in solutions sixteen times more dilute than the weakest picked out by others. Cultivation of the sense greatly increases its power. It was noticed that the pharmacy students taste weaker solutions, and with much more accuracy, than collegiate students. It seems, too, that people do not agree in their ideas of what sweetness is. A part of the variation in results may also be accounted for by the fact that some kept the liquid on the upper surface of the tongue, for the sense of taste for sweetness is more delicate on the sides of the tongue.

The first alcohols tested were those of the series $C_n H_{2n+2}O$, the monohydroxy alcohols of the paraffin group. The average strength of the weakest solutions in which sweetness could be tasted was:

Methyl alcohol CH_3OH.....1 part in 45.
Ethyl alcohol C_2H_5OH.....1 part in 41.
Propyl alcohol C_3H_7OH.....1 part in 53.
Butyl alcohol C_4H_9OH.....1 part in 39.
Amyl alcohol $C_5H_{11}OH$.....None.

No one could detect sweetness in amyl alcohol, and many could not in butyl. These results, however, are so nearly the same, and the errors of observation so great, that it may be considered that the sweetness of methyl, ethyl, and propyl alcohols is about the same; that butyl is very slightly sweet, and amyl not at all.

The second series was that represented by $C_n H_{2n+2} O_n$. The results were as follows:

Methyl alcohol CH_3OH.....1 part in 45.
Glycol $C_2H_4(OH)_2$.....1 part in 124.
Glycerine $C_3H_5(OH)_3$.....1 part in 155.
Erythrite $C_4H_6(OH)_4$.....1 part in 225.
Pentatomic alcohol, unknown.
Mannite $C_6H_8(OH)_6$.....1 part in 85.

From this it appears that the sweetness increases with each additional hydroxyl group for the first four, but that mannite is much less sweet than might have been expected, from its position and its relation to all our sugars, the carbo-hydrates.

NOTES ON SOME KANSAS METEORITES.

BY F. H. SNOW, LAWRENCE.

The description of the Kiowa county, Kan., meteorites is published in full in *Science*, vol. XVI, May 9, and July 18, 1890.

Also a description of the Washington county, Kan., meteorite, may be found in *Science*, vol. XVI, July 18, 1890.

ADDITIONS TO THE FLORA OF KANSAS.

BY B. B. SMYTH, TOPEKA.

It is fourteen years since anything like a complete list of the plants of Kansas has been published. This was done by Prof. J. H. Carruth, of Lawrence. The list contained the names of 1,082 plants. Additions made since then have increased the list to 1,515 numbers. The last addition was made in 1884.

Botanical researches through the State since then, have thrown some light on the published lists, and have disclosed some new plants. Some of the plants named in those lists have not since been seen, and are not positively known to be growing in the State. The following need confirmation, and should be erased from the list of Kansas plants:

1. Corydalis montana.
2. Nasturtium limosum.
3. Hypericum ellipticum.
4. Hypericum gymnanthemum.
5. Hypericum canadense.
6. Hypericum angulosum.
7. Alsine brevifolia.
8. Agrostemma githago.
9. Paronychia canadensis.
10. Malvastrum angustum.
11. Malvastrum pedatifidum.
12. Hibiscus carolinianus.
13. Psoralea eglandulosa.
14. Psoralea scabra.
15. Astragalus goniatus.
16. Astragalus campestris.
17. Lathyrus pusillus.
18. Desmodium neglectum.
19. Cratægus parviflora.
20. Cratægus sanguinea.

21. Ribes lacustre.
22. Ammannia nuttallii.
23. Proserpinaca pectinacea.
24. Ludwigia arcuata.
25. Œnothera bicolor.
26. Gaura longifolia.
27. Chærophyllum tainturieri.
28. Erigenia bulbosa.
29. Ligusticum actæifolium.
30. Vernonia scaberrima.
31. Liatris paniculata.
32. Eupatorium aromaticum.
33. Aster concolor.
34. Aster squarrosus.
35. Aster mutabilis.
36. Aster nemoralis.
37. Aster novi-belgii.
38. Solidago latifolia.
39. Solidago discoidea.
40. Solidago stricta.
41. Solidago rupestris.
42. Solidago angustata.
43. Solidago incana.
44. Solidago squarrosa.
45. Solidago virga-aurea.
46. Solidago puberula.
47. Solidago ulmifolia.
48. Solidago asperrima.
49. Diaperia prolifera.
50. Isopappus divaricatus.
51. Helianthus microcephalus.
52. Helianthus nocoletti.
53. Silphium lævigatum.
54. Silphium asperrimum.
55. Silphium asteriscus.
56. Coreopsis discoidea.
57. Bidens tenuisecta.
58. Echinacea atrorubens.
59. Verbesina sinuata.
60. Verbesina virginica.
61. Helenium tenuifolium.
62. Helenium quadridentatum.
63. Senecio anonymus.
64. Senecio longilobus.
65. Senecio lobatus.
66. Senecio vulgaris.
67. Cirsium ochrocentrum.
68. Tetradymia ——.
69. Specularia ludoviciana.
70. Gaylussacia resinosa.
71. Utricularia gibba.
72. Pentstemon fendleri.
73. Pentstemon brandegei.
74. Salvia azurea.
75. Heliophytum indicum.
76. Phacelia hirsuta.
77. Gilia linearis.
78. Phlox carolina.
79. Batatas macrorhiza.
80. Evolvulus sericeus.
81. Physalis heterophylla.
82. Physalis nyctaginea.
83. Physalis pennsylvanica.
84. Physalis rhomboidea.
85. Physalis mollis.
86. Physalis viscosa.
87. Solanum sisymbrifolium.
88. Sabbatia gracilis.
89. Gonolobus obliquus.
90. Fraxinus platycarpa.
91. Eriogonum tomentosum.
92. Euphorbia cordifolia.
93. Euphorbia curtisii.
94. Celtis crassifolia.
95. Quercus laurifolia.
96. Quercus falcata.
97. Quercus castanea.
98. Salix myricoides.
99. Sagittaria simplex.
100. Lachnanthes tinctoria.
101. Erythronium propullans.
102. Smilax tamnifolia.
103. Smilax pedunculars.
104. Zygadenus leimanthoides.
105. Heteranthera limosa.
106. Juncus stygius.
107. Juncus polycephalus.
108. Juncus greenii.
109. Commelyna communis.
110. Cyperus compressus.
111. Cyperus glomuliferus.
112. Cyperus nuttallii.
113. Cyperus stenolepis.
114. Eleocharis olivacea.
115. Scirpus divaricatus.
116. Scirpus linearis.
117. Fimbristylis laxa.
118. Carex cristata.
119. Carex trisperma.
120. Carex argyrantha.
121. Carex festucacea.
122. Carex adusta.

123. Carex æstivalis.
124. Carex præcox.
125. Carex novæ-angliæ.
126. Carex panicea.
127. Carex polymorpha.
128. Carex schweinitzii.
129. Sporobolus longifolius.
130. Sporobolus indicus.
131. Sporobolus montanus.
132. Agrostis elata.
133. Panicum amarum.
134. Panicum pubescens.
135. Panicum serotinum.
136. Panicum villosum.
137. Panicum xanthophysum.
138. Paspalum virgatum.
139. Alopecurus alpinus.
140. Glyceria acutiflora.
141. Glyceria aquatica.
142. Glyceria elongata.
143. Andropogon tener.
144. Andropogon tetrastychus.
145. Andropogon torreyanus.

To the above 145 species are to be added 15, that have been duplicated under the same or different names, making 160 that need to be deducted from the list as published; leaving net 1,355 species of plants in Kansas, omitting fungi.

Now, to that list as thus published is to be added the following, which is the result of the collections of the past ten years or upward. The following persons have contributed materially to this collection:

Dr. F. H. Snow, University of Kansas; Dr. J. H. Oyster, Paola; Prof. John Wherrell, Paola (also Leavenworth); Hon. Joel Moody, Mound City; Dr. W. S. Newlon, Oswego; Miss L. Cooper, Labette; Prof. E. N. Plank, Kansas City, Mo., (flora of Montgomery county); Prof. L. G. A. Copley, formerly of Wichita; Prof. M. A. Carleton, Garfield University, Wichita; Prof. O. F. McKim, Wellington; Prof. T. W. Corey, late of Conway Springs, Sumner county; Prof. Ansel Gridley, jr., Kingman; Chas. E. Hall, Hutchinson; Mrs. M. A. Moses, Great Bend, (now dead); C. C. Webb, Larned; Miss Dora Jackson, Arkalon, Seward county; Mrs. James Jackson, Golden, Grant county; Ansel Gridley, Esq., Richfield, Morton county; J. W. Stailey, Garden City, Hutchison and Topeka, (now of Lawrence); Prof. W. E. Castle, Ottawa University; Prof. Z. T. Riley, Topeka, (Greenwood county); H. E. Kinear, Topeka, (Emporia and Lyon county); Rev. Loren Armsby and Dr. H. M. Byers, Council Grove; Joseph Henry, Salina, (now dead); Supt. J. R. Bickerdyke, Russell; Dr. Louis Watson, Ellis; E. Bartholomew, Rockport, Rooks county; J. M. Waterman, Delphos, Ottawa county; Prof. E. A. Popenoe, State Agricultural College, Manhattan; F. F. Crevecœur, Onaga; Paul Wilkinson, Seneca; Prof. A. M. Nissen, late of Wetmore; Mrs. A. L. Slosson and Dr. R. J. Brown, Leavenworth; H. C. Fellow, Tonganoxie; Prof. J. H. Carruth, Dr. W. H. Saunders and Dr. A. P. Fellows, Lawrence; Prof. F. W. and Mrs. Cragin and Miss Eunice Lyman, Washburn College, Topeka; Mrs. Omar Newman, Mrs. Geo. L. Epps, Mrs. A. H. Merrell, Miss Julia Huntoon, Miss Fannie Rowley, Wm. Smith, sr., and A. T. Daniels, all of Topeka.

I am especially indebted to Prof. W. A. Kellerman, who has collected in all parts of the State and reported many plants from various points, especially in the western portion of the State, and two years ago published a complete list of the grasses, which list stands to-day with very few changes.

I am also under great obligations to Dr. Geo. Vasey, of Washington, D. C., for valuable corrections and suggestions.

Of the additions here presented, a few need confirmation, but are included because they are reported from Kansas, and are believed to exist there. Specimens of all have not been seen by me; yet very nearly all are believed to be veritable. A trip into Doniphan and Atchison counties, and three trips made by me during the past year into the western and southern parts of the State, in which nearly every county south of the Arkansas was visited, have thrown much light on the distribu-

tion of some species, and added a few new to Kansas. A few names heretofore published are here included because the locality is now made definite.

The following is the list of additions to the Kansas flora:

FLOWERING PLANTS.

1. Clematis ligusticifolia Nuttall: Phillips county.
2. Ranunculus cymbalaria Pursh: Muddy sand-bars of the Arkansas, from Garden City down.
3. Ranunculus multifidus Psh., var. terrestris Gray: Same habitat.
4. Thalictrum dioicum L.: White Cloud.
5. Thalictrum purpurascens L.: Shawnee county.
6. Argemone platyceras Link & Otto: From Manhattan west and south throughout Kansas.
7. Adlumia cirrhosa Rafinesque: Linn county.
8. Corydalis aurea Willdenow: Topeka; Council Grove; Ellis.
9. Corydalis micrantha Gr.: Topeka, Council Grove.
10. Brassica campestris L., as described by Wood in B. & F.: Topeka.
11. Biscutella wislizeni Bentham & Hooker: Liberal.
12. Erysimum asperum DC.: Clay county.
13. Erysimum parviflorum Nutt.: Wallace county.
14. Nasturtium armoracia Fries: Topeka (escaped and run wild.)
15. Nasturtium lacustre Gray: Sand-bars of the Kaw, Manhattan to Topeka.
16. Raphanus sativus L.: Topeka (escaped).
17. Cleome integrifolia T. & G.: Undoubtedly native and very abundant everywhere west and south from Hutchinson, forming vast fields in places on barren prairies.
18. Cleomella angustifolia Torr.: Hutchinson; Great Bend; Meade; Coolidge.
19. Cristatella jamesii T. & G.: From Pratt west and south.
20. Viola blanda Willd: Shawnee county.
21. Viola tricolor L., var. tenella Vasey: Manhattan; Council Grove; El Dorado; Wichita.
22. Arenaria lateriflora L.: Nemaha and Atchison counties.
23. Sagina decumbens T. & G.: Shawnee county.
24. Stellaria longifolia L.: Shawnee county.
25. Rhamnus alnifolia L'Her.: Atchison.
26. Astragalus adsurgens Pallas: Barton, Pawnee and Finney counties.
27. Astragalus cæspitosus Gray: Wallace county.
28. Astragalus flexuosus Douglas: Ellis and Ford counties.
29. Astragalus hypoglottis L.: Barton and Cherokee counties.
30. Astragalus multiflorus Gr.: Ellis county.
31. Astragalus parryi Gr.: Ellis and Meade counties.
32. Astragalus scopulorus Porter: Arkansas City.
33. Dalea formosa Torr: Rooks county.
34. Dalea lanata Sprengel: Gray and Meade counties, and west.
35. Desmanthus leptolobus T. & G.: Shawnee, Saline, and Barton counties.
36. Desmodium nudiflorum DC.: Topeka; Council Grove.
37. Desmodium rotundifolium DC.: Atchison; Valley Falls; Topeka.
38. Desmodium viridiflorum Beck: Shawnee county.
39. Hoffmannseggia jamesii T. & G.: Garden City; Arkalon.
40. Lathyrus polymorphus Nutt.: Manhattan.
41. Lathyrus venosus Muhl.: Council Grove.
42. Petalostemon gracilis N.: Garden City to Arkalon and west.

43. Psoralea campestris Nutt.: Barton and Stafford counties; Meade county.
44. Trifolium hybridum L.: Shawnee county (introduced).
45. Vicia micrantha N.: Southwest Kansas (Prof. Kellerman).
46. Physocarpus opulifolius Max.: Miami county.
47. Potentilla anserina L.: Western Kansas (Prof. Popenoe).
48. Potentilla arguta Psh.: Northwest Kansas (Kellerman).
49. Potentilla gracilis Dougl.: Topeka (very rare—probably a stray).
50. Potentilla hippiana Lehm.: Northwest Kansas.
51. Potentilla pennsylvanica L.: Shawnee county.
52. Potentilla rivalis N.: Douglas county.
53. Prunus demissa Walp.: Ellis county (Kellerman. Found on the Saline by Dr. Watson).
54. Prunus gracilis Eng. & Gray: Englewood (Kell.).
55. Prunus pennsylvanica L.: Doniphan and Brown counties.
56. Ribes oxycanthoides L.: Seneca.
57. Sedum torreyi Don: Labette.
58. Circæa lutetiana L.: Manhattan to Kansas City.
59. Didiplis linearis Raf.: Salina.
60. Œnothera biennis L., var. grandiflora Lindl.: Great Bend, Larned, Medicine Lodge.
61. Œnothera canescens Torr.: Russell and Ellis counties.
62. Œnothera cæspitosa N.: Ellis, Russell, and Barton counties.
63. Œnothera coronopifolia T. & G.: Wallace county.
64. Epilobium angustifolium L.: Doniphan and Atchison counties.
65. Gaura sinuata: Arkalon (Kellerman).
66. Jussiæa repens L.: Common in Pratt, Kingman, Harper, and Sumner counties.
67. Myriophyllum spicatum L.: Smith county.
68. Mentzelia nuda T. & G.: Sumner and Barber counties, and west and south from Clark, Gray, Finney, and Wallace counties.
69. Mentzelia ornata T. & G.: Caldwell, Medicine Lodge, Arkalon, Montezuma, Garden City.
70. Cereus cæspitosus Gray: Western Kansas.
71. Cereus viridiflorus Eng.: Grant county; Kearny county.
72. Opuntia arborescens Eng.: Stanton and Morton counties.
73. Opuntia camanchica Raf.: Morton county.
74. Opuntia fragilis Haw.: Stafford, Kiowa, Gray, and Grant counties.
75. Cymopterus glomeratus Raf.: Russell, Ellsworth, and Barton counties.
76. Cymopterus montanus T. & G.: Barton county and west.
77. Hydrocotyle Americana L.: Labette.
78. Leptocaulis divaricatus DC.: Englewood.
79. Peucedanum villosum Nutt.: Salina; Great Bend.
80. Cornus sericea L.: Council Grove.
81. Symphoricarpus racemosus Mx.: Salina.
82. Actinella linearifolia T. & G.: Riley county and west; Meade county; Kearny county.
83. Actinella odorata Gr.: Ellsworth, Great Bend, Meade, Coolidge.
84. Aplopappus divaricatus Gr.: Barton and Stafford counties, and west.
85. Aplopappus fremonti Gray: Western Kansas.
86. Aplopappus rubiginosus T. & G.: Ellis county and west.
87. Apogon humilis Ell.: Seneca (escaped).
88. Artemisia bigelovii Gray: Grant county.

89. Artemisia serrata N.: Shawnee county.

90. Aster canescens Psh.: Ellis county.

91. Aster cordifolius L.: Jackson and Shawnee counties.

92. Aster ericæfolius Roth.: Russell and Barton counties, and westward.

93. Aster linariifolius L.: Great Bend, Greensburg, Ashland, Meade.

94. Aster oblongifolius N., var. rigidulus Gr.: Topeka, Manhattan.

95. Aster paucifloras N.: Rooks and Ellis counties.

96. Aster tanacetifolius HBK.: Medicine Lodge, Meade, Montezuma, Coolidge.

97. Baccharis salicina T. & G.: Hutchinson, and on the headwaters of the Ninnescah. (The only shrub of the sunflower family in Kansas. A veritable sunflower tree.)

98. Bahia oppositifolia Nutt.: Ellis, Clark, and Meade counties.

99. Berlandiera texana DC.: Cherokee county.

100. Bigelovia douglasii, var. serrulata Gr.: Meade, Coolidge.

101. Bigelovia engelmanni Gr.: Wallace county.

102. Centaurea americana Nutt.: Montgomery county (Prof. Plank).

103. Centaurea cyanus L.: Montgomery county (Plank).

104. Cichorium intybus L.: Seneca (escaped).

105. Chrysopsis pilosa Nutt.: Emporia, Hutchinson.

106. Chrysopsis villosa N., var. hispida Gr.: Ellis, Hutchinson, Pratt, Arkalon, Garden City.

107. Erigeron bellidiastrus Nutt.: Wallace, Garden City, Arkalon.

108. Erigeron divergens T. & G.: Finney county.

109. Erigeron pumilus Nutt.: Rooks county.

110. Evax prolifera N.: Ellis county and west.

111. Flaveria angustifolia Pers.: Wichita, Hutchinson, Great Bend, Dodge.

112. Gaillardia simplex Scheele: Independence.

113. Haploesthes greggii Gray: Arkalon.

114. Helianthus annuus L.: Kansas.

115. Helianthus occidentalis Ridd.: Shawnee county.

116. Hymenopappus corymbosus T. & G.: Clay county, Barton county.

117. Lactuca acuminata Gr.: La Cygne, Labette.

118. Lactuca hirsuta Muhl.: Shawnee county.

119. Lactuca integrifolia Bigel.: Shawnee county.

120. Liatris acidota Eng. & Gr.: Nemaha and Shawnee counties.

121. Lygodesmia juncea Don: Clay, Saline, Rice, and Barber counties, and west.

122. Malacothrix sonchoides T. & G.: Wallace.

123. Marshallia cæspitosa Nutt.: Sumner and Barber counties.

124. Matricaria discoidea DC.: Atchison (introduced).

125. Melampodium cinereum DC.: Meade and Finney counties.

126. Polypteris hookeriana Gr.: Arkalon and Garden City, in sand-hills.

127. Polypteris hookeriana, discoid or rayless form: Caldwell, Kiowa, Medicine Lodge, in gypsum bluffs.

128. Prenanthes crepidinea Mx.: Shawnee county.

129. Pyrrhopappus scaposus DC.: Ellis, Russell, and Barton counties.

130. Riddellia tagetina N.: Meade, Montezuma, and Garden City, and west.

131. Senecio douglasii DC.: Russell, Barton, Stafford and Pratt counties.

132. Solidago bigelovii Gr.: Arkansas City.

133. Solidago lindheimeriana Scheele: Independence.

134. Solidago nemoralis Ait., var. incana Gray: Nemaha, Riley, and Barton counties.

135. Solidago riddellii Frank.: Shawnee county.

136. Solidago speciosa N., var. angustata T. & G.: Manhattan, Junction City, Thayer.
137. Solidago speciosa, var. rigidiuscula T. & G.: Topeka, Council Grove.
138. Solidago tortifolia Ell.: Topeka, Labette.
139. Stephanomeria runcinata Nutt.: Trego county.
140. Tanacetum vulgare L.: Lawrence, Topeka (escaping).
141. Thelesperma ambigua Gray: Western Kansas.
142. Townsendia grandiflora N.: Western Kansas.
143. Troximon glaucum Nutt.: Ellis.
144. Verbesina encelioides B. & H.: Miami county, Sumner county.
145. Vernonia baldwinii Torr.: Paola, Manhattan.
146. Vernonia jamesii T. & G.: Irving, Great Bend, Grant county.
147. Xanthium canadense Mill.: Manhattan (introduced).
148. Zinnia grandiflora Nutt.: Englewood, Liberal.
149. Centunculus minimus L.: Linn county.
150. Glaux maritima L.: Mitchell and Stafford counties, in salt marshes.
151. Samolus valerandi L., var. Americanus Gr.: Atchison county.
152. Steironema lanceolata Gray: Shawnee county.
153. Pentstemon acuminatus Dougl.: Manhattan, Ellis.
154. Verbascum lychnitis L.: Topeka.
155. Verbena pinnatifida Nutt.: Manhattan, Wichita.
156. Verbena officinalis L.: Lawrence, Topeka.
157. Verbena paniculata Lam.: Topeka.
158. Lycopus rubellus Moench: Shawnee county.
159. Lycopus sinuatus Ell.: Shawnee and Wabaunsee counties.
160. Mentha arvensis L.: Council Grove.
161. Scutellaria resinosa Torr.: Rooks county.
162. Scutellaria versicolor N.: Atchison.
163. Euploca convolvulacea Nutt.: Garden City, Montezuma, Arkalon.
164. Krynitzkia crassisepala Gr.: Garden City, Coolidge.
165. Krynitzkia jamesii Gray: Arkalon (Prof. Kellerman).
166. Lithospermum arvense L.: Topeka, Fontana, Pittsburg.
167. Nemophila microcalyx Fisch. & Mey.: Shawnee county.
168. Phacelia integrifolia L.: Medicine Lodge (Kellerman).
169. Gilia longiflora Don: Garden City, Coolidge, Arkalon.
170. Chamæsaracha coronopus Gray: Arkalon, Coolidge.
171. Chamæsaracha sordida Gray: Ashland, Ingalls, Wallace, west and south.
172. Physalis angulata L.: Lawrence, Topeka, and west.
173. Physalis lanceolata Mx., var. hirta Gray: Lawrence, Topeka, Manhattan.
174. Physalis lanceolata, var. lævigata Gr.: Lawrence, Topeka, Manhattan.
175. Petunia violacea L.: Topeka (escaping).
176. Solanum heterodoxum Dun.: Englewood, Arkalon.
177. Solanum lycopersicum L.: Topeka (escaping).
178. Solanum torreyi Gray: Paola.
179. Solanum triflorum Nutt.: Topeka.
180. Asclepias arenaria Torr.: Arkalon, Garden City, Montezuma.
181. Asclepias brachystephana Eng.: Rooks county.
182. Asclepias jamesii Torr.: Great Bend, St. John, Greensburg, Coldwater, and west.
183. Asclepias stenophylla Gr.: Manhattan, Garden City, Montezuma, Meade.
184. Asclepiodora decumbens Gray: Topeka, Council Grove.
185. Asclepiodora viridis Gr.: Manhattan, Salina, Great Bend.

186. Gonolobus lævis Mx.: Mound City.
187. Abronia fragrans Nutt.: Garden City, Montezuma, Arkalon.
188. Oxybaphus micrantha Torr.: Great Bend, Greensburg.
189. Amarantus hypochondriacus L.: Topeka (escaped slightly).
190. Amarantus viridis L.: Topeka, Great Bend.
191. Atriplex arenaria Nutt.: Great Bend.
192. Atriplex patula L., var. subspicata Wats.: Barton, Stafford, and Reno counties.
193. Chenopodium glaucum L.: Topeka.
194. Cladothrix lanuginosa Nutt.: Salina, Great Bend.
195. Corispermum hyssopifolium L.: Topeka, Hutchinson, Great Bend.
196. Salicornia herbacea L.: Cawker City, Great Bend.
197. Suæda depressa Ledeb.: Great Bend.
198. Eriogonum longifolium N.: Arkalon (Prof. Kellerman).
199. Eriogonum microthecum N.: Finney county, Grant county.
200. Eriogonum microthecum, var. effusum T. & G.: Barton and Stafford counties.
201. Fagopyrum esculentum Moench: Topeka (trying to naturalize).
202. Polygonum cilinode Mx.: Shawnee county.
203. Polygonum dumetorum L., var. scandens Gr.: Shawnee county.
204. Polygonum lapathifolium L.: Shawnee county.
205. Polygonum muhlenbergii Wats.: Shawnee county, Riley county.
206. Polygonum orientale L.: Topeka (escaped).
207. Rumex claytoni Campd.: Kaw bottoms, Lawrence to Salina.
208. Comandra pallida A.DC.: Grant county; Barber county.
209. Acalypha caroliniana Walt.: Manhattan.
210. Argyrothamnia humilis Müll.: Garden City.
211. Croton texensis Müll.: Ellis, Great Bend, Pratt, south and west.
212. Crotonopsis linearis Mx.: Lawrence; Topeka.
213. Euphorbia cyparissias L.: Topeka (running out).
214. Euphorbia lata Eng.: Chalk cliffs of Meade county.
215. Euphorbia preslii Guss.: Kansas City to Salina and Cherokee county.
216. Cannabis sativa L.: Lawrence, Topeka, Manhattan, Salina (perfectly naturalized).
217. Alnus incana Willd.: Johnson and Miami counties.
218. Carpinus americana Walt.: Miami and Linn counties.
219. Salix cordata Muhl., var. vestita Andersson: Manhattan.
220. Salix fragilis L., var.: Topeka.
221. Arisæma polymorphum Buckl.: Seneca; Topeka; Manhattan.
222. Sparganium simplex Huds., var. androcladum Eng.: Shawnee county.
223. Scheuchzeria palustris L.: Salina.
224. Triglochin maritima L.: Salina.
225. Limnobium spongia Rich.: Johnson county.
226. Vallisneria spiralis L.: Miami county.
227. Agave virginica L.: Labette and Montgomery counties (Plank).
228. Cooperia drummondii Herbert: Montgomery county (Plank).
229. Iris versicolor L.: Seneca; Atchison; Kansas City, Kas.
230. Nemastylis geminiflora Nutt.: Humboldt; Thayer.
231. Asparagus officinalis L.: Seneca, Topeka (escaping slightly).
232. Camassia fraseri Torr.: Nemaha, Wabaunsee, and Morris counties.
233. Erythronium americanum Sm.: Topeka, Manhattan.
234. Hemerocallis fulva L.: Topeka (escaped slightly).

235. Lilium philadelphicum L.: Troy; Atchison.
236. Lilium tigrinum Ker: Topeka, Great Bend (escaping).
237. Oakesia sessifolia Wats.: Atchison; Leavenworth; Lawrence.
238. Zygadenus nuttallii Gray: Onaga; Manhattan; Council Grove.
239. Juncus canadensis J. Gay: Douglas and Shawnee counties.
240. Juncus filiformis L.: Topeka.
241. Luzula campestris DC.: Troy.
242. Carex crus-corvi Shutt.: Topeka.
243. Carex filiformis L.: Salina.
244. Carex gravida Bailey: Topeka.
245. Carex longirostris Torr.: Seneca.
246. Carex tenella Schkuhr: Topeka.
247. Carex tetanica Schk., var. Meadii Bailey: Miami county.
248. Carex triceps Mx., var. hirsuta Bail.: Topeka.
249. Cladium mariscoides Torr.: Topeka, Great Bend.
250. Cyperus inflexus Muhl.: Topeka, Great Bend.
251. Cyperus rotundus L.: Topeka, Great Bend.
252. Eleocharis ovata R. Brown: Topeka, Manhattan, Great Bend.
253. Eriophorum lineatum B. & H.: Topeka.
254. Eriophorum virginicum L.: Topeka.
255. Rhynchospora capillacea Torr.: Lawrence, Topeka.
256. Scleria verticillata Muhl.: Topeka, Manhattan.
257. Agropyrum caninum Roemer & Schultes: Manhattan.
258. Agropyrum tenerum Vasey: Topeka, Manhattan, Great Bend.
259. Agrostis exarata Trin.: Topeka, Manhattan.
260. Agrostis perennans Tuck.: Topeka, Manhattan.
261. Alopecurus pratensis L.: Topeka, Manhattan.
262. Ammophila longifolia Benth.: Barton and Stafford counties; Finney county.
263. Andropogon hallii Hack.: Garden City, Montezuma, Meade, and west.
264. Andropogon laguroides DC.: Great Bend, Kinsley.
265. Andropogon macrourus Mx.: Stafford, Pratt, Barber counties, and west.
266. Andropogon saccharoides Swz.: Salina, Hutchinson, Medicine Lodge, and west.
267. Andropogon virginicus L.: Ellis, Great Bend, Pratt, and west.
268. Anthoxanthum odoratum L.: Topeka, Manhattan (trying to escape).
269. Aristida basiramea Eng.: Seneca, Salina.
270. Aristida purpurea N., var. longiseta Vasey: Salina, Great Bend.
271. Aristida ramosissima Eng.: Salina, Fort Scott.
272. Aristida stricta Mx.: Manhattan, Salina.
273. Aristida tuberculosa Nutt.: Salina.
274. Asprella hystrix Willd.: Lawrence, Salina.
275. Bouteloua racemosa Lag., var. aristosa Gray: Kaw valley, Council Grove, Great Bend.
276. Brachyelytrum aristatum Beauv.: Lawrence.
277. Brachyelytrum aristatum, var. Engelmannii Gray: Topeka, Manhattan.
278. Bromus ciliatus L., var. minor Munro: Salina.
279. Bromus kalmii Gr.: Topeka, Manhattan, Council Grove.
280. Bromus mollis L.: Topeka, Manhattan (introduced).
281. Bromus unioloides Willd.: (Kellerman).
282. Danthonia spicata Beauv.: Topeka, Manhattan.
283. Deschampsia flexuosa Griseb.: Topeka; Manhattan; Salina.
284. Deyeuxia confinis Kth.: Topeka.

285. Diplachne rigida Vasey: Arkalon (Prof. Kellerman).

286. Distichlis maritima Raf., var. stricta Thurb.: Hutchinson, Garden City.

287. Eragrostis frankii Meyer: Hutchinson; Pratt; Ashland; Arkalon; Montezuma; Garden City.

288. Eriochloa polystachya HBK.: Caldwell; Kiowa; Arkalon.

289. Eriochloa punctata Ham.: Medicine Lodge (Kellerman).

290. Festuca elatior L., var. pratensis Gr.: Topeka, Manhattan (introduced).

291. Festuca nutans Willd., var. Shortii Wats.: Southeastern Kansas (Kellerman).

292. Glyceria fluitans R. Br.: Manhattan.

293. Glyceria grandis Wats.: Lawrence; Topeka; Manhattan.

294. Gymnopogon racemosus Beauv.: Independence.

295. Hordeum pusillum Nutt. (not nodosum L.): Topeka; Manhattan.

296. Kœleria cristata Pers., var. gracilis Gray: Council Grove; Great Bend.

297. Lolium perenne L.: Manhattan (introduced).

298. Melica diffusa Psh.: Topeka, Manhattan.

299. Muhlenbergia capillaris Kth.: Independence.

300. Muhlenbergia comata Benth.: Garden City, north and west.

301. Muhlenbergia debilis Thurb.: Arkalon.

302. Muhlenbergia pungens Thurb.: Wallace, Garden City.

303. Panicum crus-galli L., var. hispidum Gr.: Kaw valley; Neosho valley; Arkansas valley.

304. Panicum crus-galli, var. hispidum, forma atropurpureum: Irving; Topeka; Hutchinson; Great Bend.

305. Panicum crus-galli, var. muticum Gr.: Hutchinson; Great Bend; Garden City; Arkalon.

306. Panicum crus-galli, var. muticum, forma purpureum variegatum: Golden, Grant county. (Leaves beautifully banded with purple bands two-thirds of a millimetre wide and about one millimetre apart.)

307. Panicum crus-galli, var. Walteri: Mound City; Oswego; Arkansas City.

308. Panicum dichotomum L., var. gracile Gr.: Wichita.

309. Panicum filiforme L.: Topeka.

310. Panicum microcarpon Muhl.: Topeka.

311. Pappophorum apertum Munro: Garden City and west.

312. Paspalum virgatum L., var. latifolium Wood: Wichita.

313. Paspalum virgatum L., var. platyoxon Doell: Cherokee county.

314. Phalaris intermedia Bosc.: Oswego.

315. Phleum pratense L., Topeka; Manhattan (escaping sparingly).

316. Poa alsodes Gray: Seneca; Topeka; Manhattan.

317. Poa andina Nutt.: Salina (Prof. Kellerman).

318. Poa flexuosa Muhl.: Lawrence; Topeka; Manhattan.

319. Puccinellia airoides Parlatore: Topeka; Manhattan.

320. Puccinellia distans Parl.: Manhattan.

321. Redfieldia flexuosa Vasey: Garden City, west and south.

322. Setaria germanica Beauv.: Topeka; Manhattan (becoming naturalized, but degenerating in the process).

323. Setaria perennis (Hall & Henry?) Salina; Hutchinson; Dodge City; Garden City; Arkalon.

324. Sorghum halepense L.: Paola; Garden City (running wild on Government farm).

325. Spartina gracilis Trin.: Wichita; Hutchinson.

326. Spartina polystachya Willd.: Salina (Henry).

327. Sporobolus arkansanus Trin.: Arkalon (Kellerman).

328. Sporobolus asperifolius Thurb.: Ellis and Dodge City, south and west.

329. Sporobolus confusus Vasey: Garden City, south and west.

330. Sporobolus indicus R. Br.: Lawrence.

331. Stipa avenacea L.: Topeka, Lawrence.

332. Stipa comata Trin. & Rupr.: Arkalon (Kellerman).

333. Stipa viridula Trin.: Topeka, Manhattan.

334. Tripsacum dactyloides L., var. monostachyon Gr.: Salina, Great Bend.

335. Trisetum interruptum Buckl.: Arkalon.

FERNS AND FILICOID PLANTS.

Collections of ferns have been made principally by Prof. F. W. Cragin, of Washburn College, assisted by Mrs. Cragin and students of Washburn College.

336. Equisetum limosum L.: Hutchinson, Great Bend.

337. Equisetum limosum, var. polystachyum Brück.: Great Bend.

338. Aspidium marginale Swz. Shield Fern: Crevices of rocks, Neosho and Walnut valleys; plentiful.

339. Aspidium thelypteris Swz. Marsh Fern: Ravines, Jackson county; rare.

340. Asplenium ebeneum Ait.: Base of mossy rocks, southeastern Kansas; occasional.

341. Asplenium parvulum Mart & Gale: Cowley county; occasional.

342. Asplenium trichomanes Link: Crevices of limestone rock, Woodson county; not common.

343. Cheilanthes lanuginosa N. Lip Fern: Ottawa and Barton counties; quite rare. (Found at "Rock City," Ottawa county, by Mrs. C. S. Mason, and sandstone bluffs along Cow creek, in northern Barton county, by Mrs. D. J. Evans.)

344. Cheilanthes vestita Swz. Lip Fern: About moss-covered rocks, Woodson county; frequent.

345. Notholæna dealbata Kunze. Calcimine Fern: Northeast face limestone bluffs, lower Kaw, Osage, Neosho, Verdigris, and Walnut valleys; quite rare.

346. Notholæna nivea Desvaux. Little Snowy Fern: Reported from Neosho county.

347. Pellea wrightiana Hook. Wright's Cliff Brake: Limestone bluffs, Ottawa county; very rare (Cragin).

348. Phegopteris dryopteris Fee. Ternate Rock Fern: Cliffs, Morris county; rare.

349. Phegopteris hexagonoptera Fee. Beech Fern: Linn county; very rare.

350. Polypodium vulgare L. Rock Polypod: Shady rock sides, Morris county; not common (Smyth).

351. Lycopodium clavatum L.: Reported from Jewell county (doubtful).

MOSSES.

A preliminary list of mosses of the State is here presented, in the hope that it may lead to a more careful study of that interesting branch of botany on the part of some of the students of the State. The principal collectors in mosses are:

Mrs. E. H. Newman, No. 14 Woodlawn avenue, Potwin Place, Topeka; Prof. F. W. and Mrs. Cragin, Washburn College, Topeka; Jerry M. Fields, Alma, Wabaunsee Co.; S. A. Baldwin, Wabaunsee; Miss Mara Becker, Netawaka, Jackson Co.; J. D. Hatcher, Long Island, Phillips Co.; Joseph Henry, Salina (since died); Dr. W. S. Newlon, Oswego; Prof. J. H. Carruth, Lawrence; Rev. John Bennett, Kansas City, Kan.

The principal authority is Eugene A. Rau, Stony Creek, Pa., as published in the Bulletins of Washburn College Laboratory of Natural History, with a few additions on the authority of Prof. Elihu Hall, of Athens, Ill., Prof. Leo Lesquereux, Columbus, O., both now dead, and Prof. T. C. Porter, Lafayette College, Easton, Pa., also a few original collections.

Acrocarpi.—Fruit terminal.

PHASCACEÆ.—Capsule sessile.

352. Ephemerum spinulosum Bruch & Schimper. Moist clay ground; common.

353. Phascum carniolicum Weber & Mohr. Sandy ground, western Kansas (Prof. E. Hall.)

354. Phascum cuspidatum Schreber. Dry soil, along fences, etc., eastern Kansas.

355. Phascum cuspidatum, var. piliferum Bruch & Schimp. Same habitat.

FUNARIACEÆ.—Capsule nodding, gibbous. Calyptra tetragonal. Peristome none or of 16 teeth, twisted to the right, sometimes with a slight inner membrane.

356. Physcomitrium acuminatum Bruch & Schimp. Moist ground; northern Kansas. (Rau.)

357. Physcomitrium pyriforme Brid. Prairies, eastern Kansas, very common; fruits in spring.

357. Physcomitrium tetragonium Bruch & Schimp. Sandy plains, western Kansas (Prof. Hall).

358. Funaria hygrometrica Sibthorpe. Bare, moist sandy ground, eastern Kansas; common.

POTTIACEÆ.—Capsule narrowly oval or cylindrical. Peristome of 16 flat teeth, bifid, or divided into 32 terete filiform segments, often twisted.

359. Barbula cæspitosa Schwaegrichen. Tree roots on hillsides; common.

360. Barbula fallax Hedw. Rocks, earth, etc.; frequent.

361. Barbula henrici E. A. Rau, n. sp. (Bull. Wash. Coll. Lab. Nat. Hist. I, 172): "Dicœcious? plants short, branched, closely cespitose, canescent from the white excurrent costæ; leaves concave, short spatulate; costæ keeled, filamentose, near apex of leaf, excurrent portion as long as the leaf, hyaline, serrate; areolation of leaves quadrate and chlorophyllose above, hyaline and elongated toward the base; leaves spreading when moist, imbricated when dry. Habitat: Rocks, Saline county (Joseph Henry). Although without fruit, it appears to be a distinct species belonging to the section Chloronotæ. It differs from Barbula chloronotos, Bruch, in its more canescent appearance, shorter and more obtuse leaves, laxer areolation, longer excurrent and more serrate costæ. Plants bearing archægonia only were sent; it is therefore desirable to secure fruiting specimens to complete the diagnosis."

362. Barbula mucronifolia Bruch & Schimp. Lime-rocks; frequent.

363. Barbula unguiculata Hedw. Damp loam, rocks, etc.; common.

365. Pharomitrium subsessile Schimp. Open ground, stone walls, etc.; frequent.

366. Didymodon rubellus Bruch & Schimp. Stones and ground, near water; frequent.

367. Leptotrichum pallidum Hampe. Bare earth in woods; common.

368. Leptotrichum tortile Muell., var. vaginans Lesquereux. Clayey and sandy soils; common.

369. Trichostomum tophaceum Brid. Moist lime-rocks; common.

DICRANACEÆ.—Capsule long-pediceled, erect or nodding. Calyptra cucullate. Operculum rostrate. Peristome simple, of 16 flat entire or bifid teeth, or none.

370. Weisia viridula Bridel. On ground, eastern Kansas.

371. Weisia viridula, var. stenocarpa Muell. Topeka.

372. Dicranella heteromalla Schimp. Rocks, clay banks; common.

373. Dicranella rufescens Schimp. Clay banks; frequent.

374. Dicranella varia Schimp. Damp banks, eastern Kansas; common.

375. Dicranum scoparium Hedwig. Southeastern Kansas (Dr. W. S. Newlon).

376. Dicranum undulatum Turner. Damp shades; common.

377. Campylopus leanus Sullivan. Soft, damp, woody earth; occasional.

378. Campylopus henrici Cardot, n. sp. (*Botan. Gazette*, August, 1888.) Saline county (Henry).

379. Fissidens decipiens DeNot. Lime-rocks, etc.; frequent.

380. Fissidens exiguus Sulliv. Stones in moist and shaded banks, etc.; common.

381. Fissidens minutulus Sull. Moist rocks in shady woods and banks; common.

382. Fissidens osmundioides Hedw. Northeastern Kansas (Miss Mara Becker).

383. Fissidens taxifolius Hedw. Shaded, clayey ground; common.

384. Leucobryum minus Sull. Bluff ground in woods; June; frequent.

385. Leucobryum vulgare Hampe. Roots of trees in damp woods; February; common.

386. Ceratodon purpureus Brid. Common.

387. Seligeria pusilla Bruch & Schimp. Shaded limestone rocks, eastern Kansas.

GRIMMIACEÆ.— Plants tufted. Capsule symmetrical, on a straight or curved pedicel. Calyptra mitriform. Peristome simple, of 16 transversely articulate teeth, or double; the outer of 8 bigeminate or 16 geminate teeth, the inner of 8 or 16 simple filiform cilia or lancolate segments.

388. Grimmia apocarpa Hedw. Damp rocks, walls, etc.; common.

389. Grimmia apocarpa, var. rivularis Nees & Hornschuch. Rocks in water-courses, eastern Kansas.

390. Grimmia calyptrata Hook.

391. Grimmia conferta Funck, var. obtusifolia Schimp. Face of dry, shaded rocks; common.

392. Grimmia conferta, var. compacta Lesq. Same habitat.

393. Grimmia leucophæa Grevius. Dry sandstone rocks; frequent.

394. Grimmia pennsylvanica Schwaegr. Rocks; common.

395. Hedwigia ciliata Ehrh. Shaded or moist sandstone rocks; occasional.

396. Ptychomitrium incurvum Sull. Sand-rocks, southeastern Kansas.

397. Ptychomitrium pygmæum Lesq. & James. Stones near streams, southeastern Kansas (Prof. Hall).

398. Orthotrichum anomalum Hedw. Lime-rocks.

399. Orthotrichum brachytrichum Schimp. Trees; not common.

400. Orthotrichum cupulatum G. F. Hoffmann. Limestone rocks, western Kansas.

401. Orthotrichum speciosum Nees. Tree trunks; common.

402. Orthotrichum strangulatum Beauv. Trees; common.

BRYACEÆ.—Capsule globose, ovoid, or pyriform; nodding, horizontal, or pendent. Peristome double; teeth barred; segments of inner membrane separated by cilia.

403. Bartramia pomiformis Hedw. Banks, southeastern Kansas; rare.

404. Philonotis muhlenbergii Brid. Springs in sand-hills, central Kansas; frequent. (E. A. Rau.)

405. Webera albicans Schimp. Damp sand, near water, northeastern Kansas (Miss Becker).

406. Webera annotina Schwaegr. Woods, eastern Kansas; not common.

407. Bryum argenteum Linn. Shades of hedges, etc., eastern Kansas; common.

408. Bryum bimum Schreb. Damp, sandy ground, rocks, eastern Kansas. (Rau.)

409. Bryum cæspiticium Linn. Common.

410. Bryum pendulum Schimp. Dead trunks; frequent.

411. Bryum pseudotriquetrum Schwaegr. Wet rocks, eastern Kansas.

412. Mnium affine Bland. Shaded banks; common.

413. Mnium cuspidatum Hedw. Damp ground, eastern Kansas; common.

POLYTRICHACEÆ.—Plants woody. Capsule cylindrical or angular. Calyptra hairy. Peristome of 32 or 64 solid teeth.

414. Atrichum angustatum B. & S. Gravelly soil in woods; common. (Rau.)

415. Atrichum undulatum Beauv. Woods, eastern Kansas.

416. Polytrichum commune Linn. Northeastern Kansas.

417. Polytrichum juniperinum Willd. Prairies, western Kansas.

418. Polytrichum piliferum Schreb. Sandy ground, western Kansas.

Pleurocarpi.—Fruit lateral.

LESKEACEÆ.—Capsule cylindrical or oblong, erect or curved. Peristome double, the outer of 16 long teeth, the inner of 16 cilia.

419. Thelia asprella Sull. Base of trees, common.

420. Leskea polycarpa Ehrh. Base of trees, eastern Kansas, freq.; limestone bluffs, northern Kansas. (Rau.)

421. Leskea rostrata Hedw. Woods, eastern Kansas, not common. (Rau.)

422. Anomodon attenuatus Hueben. Base of trees in bottoms, common.

423. Anomodon obtusifolius B. & S. Trunks of trees near water, common.

424. Anomodon rostratus Schimp. Roots of trees, eastern Kansas, frequent.

425. Pylaisia intricata B. & S. Old trees, common.

426. Pylaisia velutina B. & S. Bark of trees and old logs.

427. Cylindrothecium cladorrhizans Schimp. Dead logs and roots of trees, common.

428. Cylindrothecium seductrix Sull. Logs in shady woods, common.

HYPNACEÆ.—Capsule long-pediceled, more or less nodding. Calyptra cucullate. Peristome double; the outer of 16 lanceolate teeth, the inner a membrane divided into 16 carinate segments.

429. Brachythecium acuminatum, var. setosum. Foot of trees, dead logs, etc., eastern Kansas.

430. Brachythecium lætum B. & S. Roots and logs in woods, eastern Kansas, frequent.

431. Brachythecium plumosum B. & S. Moist rocks, eastern Kansas. (Rau.)

432. Brachythecium rivulare B. & S. Moist woods, eastern Kansas. (Rau.)

433. Brachythecium rutabulum B. & S., var. Shaded ground, roots of trees, etc.

434. Brachythecium salebrosum, var. longisetum B. & S. Moist ground, decayed logs, in woods.

435. Eurhynchium hians B. & S. Shady banks, common.

436. Eurhynchium strigosum B. & S. Sandy shades, eastern Kansas.

437. Rhynchostegium rusciforme, var. inundatum B. & S. Stones in streams.

438. Rhynchostegium serrulatum Schimp. Dry woods, eastern Kansas. (Rau.)

439. Plagiothecium sylvaticum B. & S. Rocks in dense shady spots, eastern Kansas.

440. Amblystegium radicale B. & S. Decayed logs in shade, eastern Kansas.

441. Amblystegium riparium B. & S. Stones, decayed wood, etc., in standing water, northeast Kansas.

442. Amblystegium riparium, var. cariosum Sull. Saline county. (Rau.)

443. Amblystegium serpens B. & S. Decayed wood, moist earth, and stones in shade, eastern Kansas.

444. Campylium chrysophyllum. Moist ground, dead wood, roots of trees, etc., southeast Kansas.

445. Campylium hispidulum Mitten. Ground, dead wood, etc., eastern Kansas. (Rau.)

446. Hypnum aduncum Hedw. var. Damp ground, central Kansas. (Rau.)

447. Hypnum curvifolium Hedw. Dead logs in shady woods, common.

These 447 species of plants in Kansas, added to the 1,355 already published, makes a total of 1,802 plants, not including hepaticæ, fungi, lichens, or algæ. The totals thus far are 1,666 flowering plants, 40 ferns and filicoid plants, and 96 mosses. The largest order by far is the Compositæ, embracing 292 species; next in size is the grasses, comprising 204 species; and following that is the Leguminosæ, consisting of 128 species. Other orders, except the Cyperaceæ, are less than 100. The future may reduce slightly, but will probably increase, these numbers. The work is by no means ended. There is more to come.

EXPERIMENTS IN 1890 FOR THE ARTIFICIAL DISSEMINATION OF CONTAGIOUS DISEASES AMONG CHINCH-BUGS.

BY F. H. SNOW, LAWRENCE.

At the last meeting of this Academy, at Wichita, in October, 1889, the writer presented an account of his experiments in 1889 for the artificial introduction of contagious diseases among chinch-bugs. These experiments have been continued from the date of that meeting up to the present time (November, 1890).

Inasmuch as these maladies of the chinch-bug are not kept alive in the field under ordinary out-of-door conditions of the winter season, the next important point to be gained was their preservation through the winter in the laboratory, in order that they might be under control and be available for use in the season of 1890. To accomplish this result, I placed fresh, healthy bugs in the infection jar late in November, 1889, and was pleased to note that they contracted disease and died in the same way as in the earlier part of the season. I was not able to obtain fresh germs in the spring of 1890 until the month of April, and then only a limited supply of live bugs could be secured. I quote the following from my laboratory notes:

"April 10th, twenty-five chinch-bugs that had hibernated in the field were put in the infection jars. They were supplied with young wheat plants. The bugs appeared lively and healthy.

"April 16th, some of the bugs were dead, and all appeared stupid.

"April 20th, all of the bugs were dead.

"One week later a new supply of fourteen bugs was put into the jar; they were supplied with growing wheat. They ran substantially the same course as the first twenty-five. Some had died at the end of the first week, and all were dead by the end of the thirteenth day."

The chinch-bug seemed to have been very generally exterminated in Kansas in 1889, and only three applications for diseased bugs were received in 1890 up to the middle of July. On account of the limited amount of infection material on hand, I required each applicant to send me a box of live bugs, which I placed in the infection jars, returning in a few days a portion of the sick bugs to the sender. The three applicants above noted reported the complete success of the experiments. I

give the following letter from Mr. M. F. Mattocks, of Wauneta, Chautauqua county, Kansas:

WAUNETA, KANSAS, July 7, 1890.

Prof. Snow, Lawrence, Kansas—DEAR SIR: I received from you a few days since a box of diseased chinch-bugs. I treated them according to instructions, and I have watched them closely and find that they have conveyed the disease almost all over my farm, and the bugs are dying at a rapid rate. I have not found any dead bugs on farms adjoining me. I here inclose you box of healthy bugs that I gathered 1½ miles from my place. I do not think they are diseased. Yours, M. F. MATTOCKS.

I also quote the following clipping from the Cedar Vale (Chautauqua Co.) *Star:*

"INFECTING CHINCH-BUGS.—There is no longer any need of having our crops destroyed by chinch-bugs. A remedy that is as sure as death and which costs nothing has been discovered, and is used in this county with complete success. Mr. M. F. Mattocks, living a mile and a half east of Wauneta, on the H. P. Moser farm, is entitled to the credit of demonstrating, in this part of the State, the efficiency of the remedy. He was about to lose his corn crop by the bugs that were swarming into it from the stubble. He sent to Chancellor F. H. Snow of the State University, at Lawrence, and received from him a box containing a half-dozen diseased bugs. With them he exterminated a forty-acre field full of the pests. They have died by the millions; in fact, they have about all died from the infection of those six bugs. A little circular of instructions, which he followed out, came with them. The six bugs were placed in a bottle with three or four hundred from the field, and were left together thirty-six hours and then turned loose, both the living ones and the dead, in the field. Devastation followed, and Mr. Mattocks will be troubled no more with chinch-bugs this year. If your crop is in danger you can save it by the same means of getting the diseased bugs in your field. It will cost you nothing, and is a dead-sure remedy. He has been sending dead and infected bugs to others in the country, and to Prof. Snow, whose supply was running down."

I personally visited Mr. Mattocks's farm and verified the above statements.

The difficulty of obtaining enough live bugs to experiment with in the laboratory led to the sending out of the following advertisement, which was forwarded to twenty prominent papers, with requests for its publication:

"WANTED! CHINCH-BUGS!—Prof. F. H. Snow, of the University of Kansas, is in great need of some live and healthy chinch-bugs with which to carry on his experiments in chinch-bug infection. Anyone who will send a small lot of bugs to Prof. Snow, University of Kansas, Lawrence, Kansas, will confer a favor on the investigator, and, it is hoped, on the farmers of Kansas."

This request for live bugs was given wide circulation, and resulted in keeping the laboratory fairly well supplied with material for experiment.

Before the close of the season of 1890 it became evident that there were at least three diseases at work in our infection jars: the "white fungus" (*Entomophthora* or *Empusa*), a bacterial disease (*Micrococcus*), and a fungus considered by Dr. Roland Thaxer to be *Isaria*, or perhaps more properly *Trichoderma*.

The following report, which describes the bugs as "collecting in clusters," points to the bacterial disease as the cause of destruction:

PIQUA, WOODSON COUNTY, KANSAS, July 12, 1890.

Prof. Snow, State University, Lawrence, Kansas—DEAR SIR: Since writing you from Humboldt, Kansas, the 6th inst., have made the happy discovery that the germs of contagious disease sent me were vital. On Sunday last, upon examination of the millet field, I found *millions of dead bugs.* They were collected in clusters. My idea is that dampness facilitates the spread of the contagion. The first distribution of diseased bugs, two days after I received the package by mail, apparently produced no results. A part of them were retained in the infection jar (quart Mason fruit jar). A half-pint of bugs were collected from the field. Three days later a foul stench was found to emanate from the jar, and a part of the bugs in it were dead. On July 3, I took advantage of the cool, damp evening, and took a few buckets of cold water and sprinkled the edge of the millet, and distributed more infected bugs. On the 6th I found millions of dead bugs. I think the night, and sprinkling the millet, caused the disease to spread. We have had no rain in this neighborhood since June 17, if I remember correctly. The depredations of chinch-bugs are always more serious in dry, hot weather.

You have conferred a lasting benefit on the farming interests of the United States, the value of which cannot be estimated in dollars and cents. It was estimated that, during one of the visitation years of this insect, the damage in the Mississippi valley amounted to ten millions of dollars. I have no doubt that by a proper manipulation of the contagious disease, in the hands of intelligent persons, it will prove an effective remedy. I think the contagion should be introduced among them early, to prevent the migration of the young brood. In my case I received it too late. Early-sown millet pre-

sents a favorable place to infect the bugs, as they seem to collect in the shade and die. Hoping that when the next Legislature meets an appreciating public will suitably reward you for your beneficent discovery, I am, Gratefully yours, J. W. G. McCORMICK.

The field experiments were apparently equally successful in the months of July, August, and September.

The following August field report is inserted as a fair sample of the manner in which the farmers themselves regard these experiments:

FLORENCE, KANSAS, November 1, 1890.

Prof. F. H. Snow—DEAR SIR: On the 20th of August (I think it was) I wrote to you to send me some infected chinch-bugs, and on the 30th of the same month you sent me a small lot of infected bugs (I suppose about thirty in all). I then put with these about twenty times as many healthy ones and kept them forty-eight hours, and then deposited them in and through my field. (I have about fifty-five acres under cultivation.) At the time I wrote for bugs my place was all in corn and a very large crop of chinch-bugs. I am safe in saying that there were more bugs on my farm than any two with the same amount of land under cultivation. At the time of sending to you for bugs I told two of my neighbors of my intention, and they laughed at the idea; nevertheless I sent. When I put them in my field it had rained fully a half-day, and after noon I commenced to place them about in different places in my field. I noticed no change in the bugs for three days, it being cold, and on the fourth and fifth days the weather was more warm, and it was then that the destruction of the enemy commenced, with great satisfaction to myself and great surprise to my laughing neighbors. One of my neighbors, Mr. George Winchester, said that there ought to be a subscription raised and donated to me. I told him not to me, but to you the praise belonged.

I think that it took about eight days after the fifth from the time that I placed them in my field before they were all destroyed. The fifth day after I put out the diseased bugs I noticed that a great many bugs were flying away from my place. I cannot say if the disease spread in this way or not, or if it spread at all. Three or four persons said that they would come and procure of me some of the dead bugs, but no one came.

This much I can say: with me this experiment has been a complete success. It has done me a great deal of good. I cannot give it a money value, but am satisfied that had it not been for the infected bugs obtained of you I would have lost twenty-seven acres of wheat and eight acres of rye, and when I wrote to you for bugs I then contemplated putting out considerable wheat, and I was at that time considerably troubled about the bugs in my corn, thinking that if I put out any wheat at all it would be destroyed by bugs; but, thanks to you, my wheat is now safe from bugs, at least those that were on my place before sowing my wheat. I only wish that I had written to you sooner.

I will send by express one bottle of bugs that I gathered after they commenced to die.

Respectfully, JOHN F. KNOBLE.

The following report from R. L. Staugaard is inserted as being of a more scientifically circumstantial character than most of the other reports:

FLORENCE, KANSAS, August 22, 1890.

Prof. F. H. Snow, Lawrence, Kan.—DEAR SIR: In reply to your favor of July 27, last month, would say, that infected bugs were applied after they were kept with live ones about 42 hours. They were applied as follows:

Most of the bugs mixed were dead when taken out of the box. They were applied in seven different hills, being put into every ninth hill. I marked every hill with a number so as to be better able to watch the progress.

Examined after 48 hours' application, with the following results: No. 1, mostly dead; No. 2, mostly alive—seemingly very restless; No. 3, bugs seem to be sick; No. 4, bugs mostly dead, (on hills around this, bugs seemed restless;) No. 5, not examined, (on hills around it the bugs seemed to be affected.) Examination three days after application with the following results, to wit: No. 3, bugs seemingly in a dying condition, (on the hills around it the bugs seemed to be well with the exception of one hill, where they seemed to be dying, and some dead.) No. 4, not a live bug in the hill; No. 5, apparently dying, also dying in the hills around this; No. 6, bugs dying in the hill; No. 7, apparently not dying.

On August 16th, twelve days after application, I found the bugs to be dying and dead all through the field (12 acres).

On August 20th, I again found the bugs to be dying rapidly. A field being forty rods distant had sure marks of bugs in a dying condition. What I mean by bugs being in a dying condition is this they lay on their backs almost motionless, and others lay in the same position moving limbs violently.

This remedy was applied on A. G. Rosiere's farm, on Bruno creek, Marion county, Kas., being nine miles east and three miles south of Marion.

Thanking you for your favors, I remain, yours truly, R. L. STAUGAARD.

The laboratory experiments have been continued through the season. Of the three diseases identified, that produced by the Trichoderma appears to be less fatal than the other two, as is indicated by the following laboratory notes:

"September 28th, dead chinch-bugs, showing no signs of fungus externally, were taken from the infection jars and crushed on a glass slide in distilled water. Oval hyphal bodies of a fungus (*Trichoderma*) were found in considerable number. These were put under a bell jar.

"September 29th, some of the hyphal bodies had put out slender, mycelial growths; others in immense numbers were multiplying by division.

"October 1st, the hyphal bodies were still multiplying by division. The mycelial growths had become much larger, and in some instances had variously branched.

"October 3d, a dead chinch-bug taken from an infected field was crushed on a glass slide in distilled water. Both round and oval hyphal bodies were found in considerable number. These were put under a bell jar to prevent drying.

"October 4th, both round and oval hyphal bodies were multiplying by division, and were putting out mycelial growths.

"October 5th, fresh chinch-bugs, from an uninfected field, were immersed in the liquid containing the above fungi, and were put in a new jar with young corn plants."

The following is a summary of the results of the field experiments in the season of 1890:

Number of boxes of diseased bugs sent out, thirty-eight. Seven of these lots were either not received, or received and not used. Reports were received from twenty-six of the thirty-one remaining cases. Of these twenty-six reports, three were unfavorable, nineteen favorable, and four doubtful concerning the success of the experiment. These doubtful cases are not to be looked upon as unfavorable, but more evidence is needed to transfer them to the list of favorable reports. These nineteen out of twenty-six reports, or seventy-three per cent., were decidedly favorable. The experiments will be continued during the season of 1891.

In presenting this paper I wish to acknowledge the invaluable aid continually received during the progress of the work from my assistants, Messrs. W. C. Stevens and V. L. Kellogg.

SOME EXPERIMENTAL TESTS OF THE PASTEUR FILTER.

L. E. SAYRE AND V. L. KELLOGG, LAWRENCE.

It is claimed for the Pasteur filter that it perfectly filters water (or other liquids) of, among other impurities, bacteria; that water teeming with disease-producing germs after being filtered by means of this contrivance, is wholly free from their presence. The filter is well known; to the few who may not have seen it, it may be said that an unglazed earthenware cylinder closed at one end is introduced into a metal cistern or jacket, which may be filled with water, or other fluid. The open end of the filter projects from the cistern through a perfectly tight collar. The fluid in the cistern filters through the cylindrical earthenware cup, and is received from its projecting open end.

It is evident at first glance after filtering nutrient solutions, as hay and turnip infusions turbid with bacilli, that the filter restrains the great majority of the minute forms from passing into the earthenware cup with the liquid, as the filtered fluid is always clear and colorless. No interception and reflection of light from the microscopic bits of life is to be noted by the naked eye on examining the filtered

fluid, though before filtering, it may have been fairly milky. But very few bacilli are required, however, to give rise to a typhoid epidemic in the face of favorable conditions. The restraining of the bacilli should be absolute. The following experiments were carried on with a view to determining the perfectness of the filtration in the case of the filter under examination:

Oct. 29, 1890.—Hay cut into short pieces was digested in .8 litre distilled water at 55° C. from 4 P. M. to 6 P. M. in water bath. Pieces of hard white were turnip similarly digested.

Oct. 30.—Renewed the digesting for one hour. At 11:30 A. M., filtered the infusion through clean filters into clean beakers. The hay infusion was of a rich brown color; the turnip, colorless. Part of each infusion was put into a beaker, and set aside under a larger inverted beaker. That beaker containing the filtered unsterilized turnip infusion was labeled 29, the hay 28. (See further reference.) The remaining portions of the infusions were boiled intermittently (at intervals of about ten minutes) for one hour. Nine test-tubes, (new) thoroughly washed and oven-dried, were taken from the hot oven, flamed, (*i. e.*, the flame from a Bunsen burner was allowed to play on every portion of inner and outer surface, the tube being held in cleaned and flamed forceps,) and suspended in a water-bath. Into these tubes boiling hay infusion was poured. The temperature of the water-bath was brought up to the boiling point and the infusion tubes were allowed to boil intermittently for some time. The mouth of each was plugged with clean absorbent cotton, previously heated in oven and handled with sterilized forceps. Over each plugged mouth a double fold of cotton was closely fastened with a rubber band. The tubes were labelled 3, 4, 5, 6, 7, 8, 9, 10, (one of the nine dropped and was broken,) and set vertically in a rack. Eight tubes of sterilized turnip infusion were similarly prepared, and labeled 11, 12, 13, 14, 15, 16, 17, 18

A number of Sternberg flasks, *i. e.*, small, long-stemmed flasks, made by blowing out glass tubing and drawing the stem out, had been prepared (hermetically sealed when made) and were charged with the sterilized infusions. The introduction of the fluid was effected by breaking off the tips of the flasks with sterilized forceps, slightly heating the bulbs and pushing their broken stems into the boiling infusion, when the contraction of the cooling air in the bulb would allow the ingress, by the outside pressure, of a small quantity of the liquid. The tip of the stem was then sealed by holding in a Bunsen flame. Six flasks were charged with sterilized hay infusion and placed together in a beaker labeled 19; six were similarly charged with turnip infusion and placed in beaker 20. After the introduction of the boiling liquid it was in some cases boiled in the flask, but not always.

Two sterilized test-tubes were charged with sterilized hay infusion and placed in rack with mouths open. These were numbered 22 and 23. A third tube containing sterilized hay infusion was *loosely* plugged with cotton, and labeled 24. Two open tubes of turnip infusion were prepared, and numbered 25 and 26. The remainder of the hay infusion, sterilized, but allowed to stand for three hours uncovered, was poured into an open test-tube and labeled 27. With the open hay tubes a defective hay flask, *i. e.*, one which had a small hole in tip of stem, was placed, and numbered 30.

November 3d the earthenware filter was taken from the metal cistern and heated in oven at high temperature for one-half day. It was then thoroughly flamed and its small mouth plugged with clean cotton, and cotton tied over it. It was then suspended, after cooling so that no undue expansion might make it less perfect in its filtration, with the plugged mouth projecting, in a nutrient solution known as Pasteur's solution (calcium nitrate, 4 parts; potassium phosphate, 1 part; magnesium sulphate, 1 part; potassium nitrate, 1 part; distilled water, 700 parts), which

had been previously prepared and was now fairly milky by reason of its swarms of active bacteria, a dumb-belled micrococcus. The filter remained in this solution, a drop of which examined under the microscope showed myriads of micrococci, from 3:15 P. M. November 3, until 8:30 A. M. November 4.

November 4th, at 8:30 A. M., the filter was removed from the Pasteur solution, and with a delicate sterilized pipette four drops of the filtered solution were taken from the filter and introduced into turnip infusion tube 11 by removing the cotton plug and cover, and quickly and carefully replacing them. Same with turnip infusion tube 17, and with hay infusion tubes (only three drops each in hay tubes). All of these tubes were perfectly clear, and showed no signs (turbidity) of the presence of bacteria. Two drops each of the *unfiltered* Pasteur solution, containing micrococci, were introduced into tubes 6 and 12 (one hay and one turnip). These tubes were both clear, and showed no change since being charged. The filter was then replaced in the bacterial solution, and at 3 P. M. one hay flask and one turnip flask (neither flask showing any change since day of charging) were inoculated with a drop or two of the filtered solution, and placed in a beaker numbered 31. The introduction of the filtered solution into the flasks was made by breaking off the tips of the flasks' stems with sterilized forceps, and using an extremely fine sterilized pipette which could be inserted in the stem of each flask. Two other flasks — a hay and a turnip — were inoculated with the unfiltered solution and put into a beaker numbered 32. Ten drops of the filtered solution were successively examined with a microscope, using a magnification of about 500 diameters, and *no* bacteria were found. The remainder of the filtered solution was put into two sterilized tubes which were *loosely* plugged with cotton.

During the afternoon the filter was resterilized and suspended in unsterilized turnip infusion (from 29), which was turbid with bacteria. Tubes and flasks were inoculated as follows (all about 3 P. M.):

With filtered infusion, tubes 7 (with three drops), 13 (with three drops), flasks 13+, 7+.

With unfiltered infusion, tubes 9 (with two drops), 14 (with two drops).

Several drops of the filtered infusion were examined by Mr. Stevens, assistant in botany, and were reported by him to contain a few, two or three to the drop, bacteria which did not move, and were apparently lifeless.

All of these tubes and flasks were kept in a room having a fairly equable temperature of about 32 C. The room had not been used recently, and though dirty and in disorder, the atmosphere was presumably fairly free from bacterial or other fungoid spores. The room was kept locked and the tubes sat on a table in the middle of the room and at no time of the day in direct sunlight. There were no changes of temperature tending to cause strong air-currents either in the tubes or about them. Observations were made often, but the ones here recorded show the changes noted in the fluids, and the incidents connected therewith, up to date of this writing. Each tube and flask is considered separately, and is referred to by number. Those prepared tubes and flasks not referred to were used in other experiments incident to the ones here described:

Tube No. 4: Charged Oct. 30, 12:30 p. m., with sterilized hay infusion; closed with cotton.

Nov. 4, 9 a. m., clear; no change; inoculated with three drops filtered Pasteur's solution, which before filtering swarmed with dumb-bell micrococci.

Nov. 5, 3 p. m., clear; no change.

Nov. 10, 2 p. m., clear; a small patch of penicillium on surface.

Nov. 15, 12:30 p. m., clear; fungus patch larger on surface and a small patch at bottom of tube.
Nov. 24, 3 p. m., clear; fungus at top and bottom.

Tube No. 5: Charged same as No. 4; closed with cotton.
Nov. 4, 9 a. m., inoculated same as No. 4.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 6: Charged same as No. 4; closed with cotton.
Nov. 4, 9 a. m., inoculated with two drops unfiltered Pasteur solution, swarming with dumb-bell micrococci.
Nov. 5, 2:30 p. m., turbid; not clear.
Nov. 10, 2 p. m., turbid; hazy.
Nov. 15, 12:30 p. m., turbid.
Nov. 24, 3 p. m., turbid.

Tube No. 7: Charged same as No. 4; closed with cotton.
Nov. 4, 3 p. m., inoculated with three drops of filtered turnip infusion from beaker No. 29.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Flask No. 7*a*: Charged same as tube No. 7, and similarly inoculated; closed with cotton.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 8: Charged same as No. 4; closed with cotton.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 9: Charged same as No. 4; closed with cotton.
Nov. 4, 3 p. m., inoculated with two drops unfiltered turnip infusion from beaker 29.
Nov. 5, 3 p. m., turbid; slightly.
Nov. 10, 2 p. m., turbid, and streaked with fungus mycelium.
Nov. 15, 12:30 p. m., turbid, and growing mould.
Nov. 24, 3 p. m., apparently clear, but much mould present.

Tube No. 10: Charged same as No. 4; closed with cotton.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 11: Charged Oct. 30, 3 p. m., with sterilized turnip infusion; closed with cotton.
Nov. 4, 9 a. m., clear; no change. Inoculated with four drops filtered Pasteur solution, which solution before filtering swarmed with dumb-bell micrococci.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.

Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 12: Charged same as No. 11; closed with cotton.
Nov. 4, 9 a. m., clear, no change; inoculated with two drops unfiltered Pasteur solution, teeming with micrococci.
Nov. 5, 3 p. m., turbid; milky.
Nov. 10, 2 p. m., turbid; milky.
Nov. 15, 12:30 p. m., turbid; milky.
Nov. 24, 3 p. m., turbid; milky.

Tube No. 13: Charged same as No. 11; closed with cotton.
Nov. 4, 3 p. m., clear, no change; inoculated with three drops filtered turnip infusion, which before filtering swarmed with bacteria.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Flask No. 13*a*: Charged same as tube 13, and similarly inoculated.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 14: Charged same as No. 11; closed with cotton.
Nov. 4, 3 p. m., clear, no change; inoculated with two drops unfiltered turnip infusion, swarming with bacteria.
Nov. 5, 3 p. m., turbid.
Nov. 10, 2 p. m., rather turbid; much mould, and a white precipitate at bottom of tube.
Nov. 15, 12:30 p. m., turbid; milky.
Nov. 24, 3 p. m., clear, but much mould throughout the liquid.

Tube No. 15: Charged same as No. 11; closed with cotton.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 16: Charged same as No. 11; closed with cotton.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Tube No. 17: Charged same as No. 11.
Nov. 4, 9 a. m., inoculated with four drops filtered Pasteur solution, which before filtering swarmed with micrococci; closed with cotton.
Nov. 5, 3 p. m., clear; no change.
Nov. 10, 2 p. m., clear; no change.
Nov. 15, 12:30 p. m., clear; no change.
Nov. 24, 3 p. m., clear; no change.

Beaker No. 19: Containing six Sternberg flasks, charged Oct. 30, 3 p. m. with sterilized hay infusion.
Nov. 5, 3 p. m. There are but two flasks left in the beaker. The infusion in them is clear, and shows no change. The other flasks

when taken out to be inoculated, were clear and showed no change.

Nov. 10, 2 p. m., the two flasks clear; no change.

Nov. 15, 12:30 p. m., the two flasks clear; no change.

Nov. 24, 3 p. m., the two flasks clear; no change.

Beaker No. 20: Containing six Sternberg flasks, charged Oct. 30, 3 p. m., with sterilized turnip infusion.

Nov. 5, 3 p. m. There is but one flask left in the beaker. The infusion in it is clear, and shows no change. The other flasks when taken out showed no change.

Nov. 10, 2 p. m., the one flask clear; no change.

Nov. 15, 12:30 p. m., the one flask clear; no change.

Nov. 24, 3 p. m., the one flask clear; no change.

Tube No. 22: Charged Oct. 30, 4 p. m., with sterilized hay infusion and left open.

Nov. 5, 2:30 p. m., clear! no change. [Compare with tubes 25, 26, 27.]

Nov. 10, 2 p. m., clear! no change.

Nov. 15, 12:30 p. m., clear! no change.

Nov. 24, 3 p. m., clear! no change.

Tube No. 23: Charged same as No. 22; left open.

Nov. 5, 2 p. m., clear; on the surface of the liquid in the middle slight impurities have collected.

Nov. 10, 2 p. m., clear! no change.

Nov. 15, 12:30 p. m., clear; no change.

Nov. 24, 3 p. m., clear; no change.

Tube No. 24: Charged same as No. 22, and a *loose* plug of cotton put in mouth.

Nov. 5, 2:30 p. m., clear; no change.

Nov. 10, 2 p. m., clear; no change.

Nov. 15, 12:30 p. m., clear; no change.

Nov. 24, 3 p. m., clear; no change.

Tube No. 25: Charged October 30, 4 p. m., with sterilized turnip infusion, and left open.

Nov. 3, 2 p. m., penicillium growing on surface.

Nov. 4, 3 p. m., penicillium fruiting; liquid turbid.

Nov. 10, 2 p. m., liquid milky, and surface covered with mat of penicillium.

Nov. 24, 3 p. m., liquid milky, and penicillium covering surface.

Tube No. 26: Charged same as No. 25, and left open.

Nov. 3, 2 p. m., penicillium growing on surface.

Nov. 4, penicillium fruiting; liquid turbid.

Nov. 10, 2 p. m., liquid turbid and surface covered with penicillium.

Nov. 24, 3 p. m., liquid turbid and penicillium covering surface.

Tube No. 27: Charged October 30, 9 p. m., with once sterilized turnip infusion left standing in uncovered beaker for three hours. Left open.

Nov. 1, 9 a. m., turbid.

Nov. 3, 2 p. m., penicillium growing on surface and a white precipitate at bottom of tube.

Nov. 4, 3 p. m., precipitate heavier; liquid clearing.

Nov. 10, 2 p. m., turbid, and fungus on surface.

Nov. 24, 3 p. m., turbid, and penicillium on surface.

Beaker No. 29: Filled with unsterilized turnip infusion October 29, 11:30 a. m., and covered with inverted beaker.

Oct. 30, 9 a. m., turbid; slightly milky.

Oct. 31, 12 m., examined drop of the turbid fluid with microscope and found it to be swarming with bacteria.

Beaker No. 31: Containing two Sternberg flasks, one of sterilized hay infusion, one of sterilized turnip infusion, charged October 30.

Nov. 4, 3 p. m., inoculated each flask with a few drops of filtered Pasteur solution.

Nov. 5, 3 p. m., clear; no change.

Nov. 10, 2 p. m., clear; but the turnip flask containing small patches of mould.

Nov. 15, 12:30 p. m., clear; the mould in turnip flask not growing much.

Nov. 24, 3 p. m., clear, but considerable white mould in turnip flask.

Beaker No. 32: Containing two flasks, same as No. 31.

Nov. 4, 3 p. m., inoculated each flask with small quantity of unfiltered Pasteur solution containing bacteria.

Nov. 5, 3 p. m., both flasks turbid; the turnip milky, the hay hazy.

Nov. 10, 2 p. m., the hay-flask clearing; a white sediment in bottom of flask; the turnip turbid, with a little sediment.

Nov. 15, 12:30 p. m., turnip-flask milky; the hay rather clear, with sediment at bottom.

Nov. 24, 3 p. m., turnip turbid, with sediment; the hay clear, with sediment.

Tube No. 33: Charged Nov. 4, 3 p. m., with filtered Pasteur solution; clear. *Loosely* plugged with cotton.

Nov. 5, 3 p. m., perfectly clear.

Nov. 10, 2 p. m., slightly turbid.

Nov. 24, 3 p. m., turbid.

Tube No. 34: Charged same as No. 33.

Nov. 5, 3 p. m., perfectly clear.

Nov. 10, 2 p. m., slightly turbid.

Nov. 24, 3 p. m., turbid.

SUMMARY.

The culture tubes were kept from Oct. 30, 12:30 p. m., to Nov. 4, 9 a. m., before any inoculations were made. They seemed to be free from bacteria at this time. The sterilization and protection from attack by floating germs seemed to be perfect. Tubes 8, 10, 15 and 16, not inoculated, are to-day (Nov. 23) as clear as when charged. Nor is this due to lack of nutrition in the culture fluids; for tubes 6, 9, 12 and 14, inoculated with solutions containing bacteria, became turbid within 24 to 30 hours. And tubes 25, 26 and 27 (turnip), left exposed to the quiet air of the room, became turbid within a few days. The behavior of tubes 22 and 23 (hay), exposed to the same air, is quite inexplicable to us. This hay infusion furnished pabulum for the *motile* bacteria thrust into it by inoculation, but the dry bacterial and penicillial *spores* floating in the air were not able to germinate in it. The infusions in the flasks show this same readiness to furnish pabulum for introduced bacteria (see flasks in beaker 32), and show the infusions to have been perfectly sterilized, and no bacteria appear in those flasks not inoculated (see flasks in beakers 19 and 20).

It is fair to presume that if any motile bacteria penetrated the walls of the earthenware filter, that the inoculation of these culture tubes with the filtered liquids would be followed by the appearance of bacteria (perceived by films or turbidity) in the tubes. The notes on tubes 4, 5, 7, 11, 13, 17, and flasks 7*a*, 13*a*, and those in beaker 31, indicate a very effective restraining action by the filter. The

development of bacteria in tubes charged with the filtered liquids after several days is explained by the intentionally imperfect sealing (tubes 33 and 34.) The microscopic examinations of the filtered liquids discovered no bacteria in the case of one of the liquids, and a few non-motile apparently lifeless ones in the case of the other (Mr. Stevens's examination). The presence of penicillium in the tubes is to be explained by anevident abundance of floating spores in the laboratory. These spores must have been so abundant that in the short time the cotton plugs and covers were removed from the tubes to allow inoculation, one of the tubes was infected (see tube 4), and, more wonderful still, one of the flasks, while its tip was broken, managed to receive one or more of the spores into its depths. (See turnip flask in beaker 31.) It is possible that the spore or spores had fallen through the small mouth of the filter and into the filtered liquid, and thence been conveyed to the tube and flask; or that the pipette used, though well flamed, may have been the agent of introduction. The penicillium appearing in tubes 9 and 14 was undoubtedly introduced with the unfiltered turnip infusion, as this infusion had been more or less exposed to the spore-laden atmosphere of the laboratory. However, the experimenters congratulate themselves on the evident success of the sterilization of the culture tubes and flasks. That the mould spores came from the atmosphere rather than from the cotton used in sealing the tubes, is shown by the immediate appearance of penicillium in those tubes left exposed. (See tubes 25, 26 and 27.) In addition to the tests of the filter, observations on the effectiveness of certain methods of handling culture tubes were made, which need not be referred to here.

FIRST ADDITION TO THE LIST OF KANSAS PERONOSPORACEAE.

BY W. T. SWINGLE, B. SC., MANHATTAN, KANSAS.

I published in vol. XI of these Transactions (pp. 63–87) "A List of the Kansas Species of Peronosporaceæ" including the species found within the State up to October, 1889. The paper was also reprinted with the original pagination, and distributed November 1, 1889. I have now a few corrections and additions to report in the list. The additions to the list are arranged as in the original list, and include all specimens collected from October, 1889, to November 1, 1890, and also a few collected before this which were omitted from the original list.

All new localities, host plants, or species new to the State, finding of oospores on hosts where not previously reported, and collection of conidia or oospores in a new month, are shown by the words indicating the fact being printed in **BLACK-FACED** type.

All of the numbers listed here are in my herbarium and also in that of Prof. W. A. Kellerman:

CORRECTIONS IN THE ORIGINAL LIST.

Page 64, line 6 from top, for Schleseins read Schlesiens.
" " " 29 " " strike out *and* and add after *Hedeomae and P. candida.*
" 66 " 20 " " for Leveille read Léveillé.
" " " 11 " bottom, strike out *with immature oospores.*
" " " 4 " " " " *with very young oospores.*
" 67 " 12 " top, after 1538 add *with nearly mature oospores.*
" " " 21 " " " on, add *stems and.*
" " " 22 " " " 293 strike out *with young oospores.*
" " " 24 " " " on, add *stems and.*

Page 68, line 24 from top, for Lev. read Lév.
" " " 5 " bottom, after 158, insert *with mature oospores.*
" 70 " 4 " top, after SCLEROSPORA strike out Schroeter, in Cohn Krypt. Flora Schles., III Band, S. 236, and insert instead (Schroeter) de Bary, Zur kenntniss der Peronosporeen, in Botanische Zeitung, XXXIX Jahrg., Nr. 39, 30. September, 1881, S. 621.
" 73 " 17 " bottom, insert before 1641, M. A. Carleton No. 163, June 19, 1886, Cloud county; and strike out the same entry from under *Ambrosia trifida* L., p. 73, lines 10 and 9 from bottom.
" 75 " 5 " " before Jahrg. insert III, and for p. 251 read p. 231 Nr. 21.
" 76 " 6 " " after 80, insert, *with mature oospores.*
" " " 5 " " " 80*b*, insert, *with immature oospores.*
" 79 " 25 " top, for *Major* L. read *Rugelii* Decaisne.
" 80 " 7 " bottom, for Anaggallis read Anagallis.
" " " 2 " " " Anagalis read Anagallis.
" 83 " 21 " top, " EFFUSA read EFFUSA.
" 84 " 7 " bottom, " SORDIDA read SORDIDA.

ADDITIONS TO THE ORIGINAL LIST.

PERONOSPORACEAE DE BARY.

1. Cystopus candidus (Pers.) Lév.

On *Sisymbrium canescens* Nutt.

1961, on leaves, March 24, 1890, Manhattan; 1962, on leaves, April 4, 1890, Manhattan; 1963, on leaves, April 28, 1890, Manhattan; 1964, on leaves, with abundant mature oospores in slightly swollen stems, May, 1890 (?). The date of collection of these valuable oospore-bearing specimens is unfortunately somewhat uncertain. The oospores agree very closely with the description and figures given by de Bary Rech. sur le développment de quelques champ. parasites, in An. Sci. Nat., série 4 t. XX, p. 131 (p. 126 of the reprint), Pl. 2, fig. 2–12.

On *Capsella Bursa-pastoris* Moench.

1965, collected by M. Varney, on leaves and stems, with abundant mature oospores in the swollen ends of the stems, and in distorted flowers, June, 1890, Manhattan.

On *Brassica nigra* Koch.

1956, with oospores in swollen stems, petioles and flowers, no conidia, July 7, 1890, Manhattan; 1957, with oospores only in swollen stems and flowers, July 31, 1890, Manhattan. This species was fully as abundant as in 1889, and likewise only oospores could be found when the specimens were collected. The oospores do not agree with the description and figures usually given of *Cystopus candidus*, being often more like those of a *Peronospora* of the *effusa* type. A few were furnished with a very finely warted epispore, but none were seen with the characteristic coarse warts found in typical specimens. It may be that the oospores, from being so crowded in the tissues of the parts attacked, stunted each other, since the host-plants themselves were much injured by drouth. The specimens collected July 4, 1887, (see list, p. 67,) had oospores showing the usual markings.

On *Lepidium intermedium* Gr.

1958, on leaves, April 4, 1890, Manhattan; 1959, on leaves, April 28, 1890, Manhattan; 1960, on leaves, May 8, 1890, Manhattan; 1998, on leaves of seedling plants, OCTOBER 19, 1890, Manhattan.

2. **Cystopus Ipomoeae-panduranae** (S.) Stevenson & Swingle.

On *Ipomoea hederacea* Jacq.

1966, on leaves, August 20, 1890, Manhattan.

In Seymour and Earle, Economic Fungi Fascicle I., January 1, 1890, No. 47, this species is given as *Cystopus Ipomoeae-panduranae* (S.) Farl. Farlow and Seymour, in their Provisional Host-Index of the Fungi of the United States, Part II., September, 1890, pp. 81 and 82, also give the name in this manner. Although Prof. Farlow said in August, 1889,[1] "Undoubtedly the first name given to the form on *Convolvulaceae* in North America was *Æcidium Ipomoeae-panduranae*," yet he nowhere actually called the species *Cystopus Ipomoeae-panduranae*. This was first done by Mr. W. C. Stevenson, jr., and myself in my list (p. 67, No. 2), which was published November 1, 1889; so the name should be given *Cystopus Ipomoeae-panduranae* (S.) Stevenson et Swingle.

3. **Cystopus Portulacae** (DC.) Lév.

On *Portulaca oleracea* L.

1967, July 12, 1890, Manhattan; Mr. E. Bartholomew, No. 236, on leaves, July 15, 1888, Rockport, Rooks county; 1970, coll. W. T. Allen, on leaves, August 13, 1890, Manhattan; 1968, with abundant mature oospores, on leaves, August 20, 1890, Manhattan; 1969, with abundant mature oospores, on leaves, August 20, 1890, Zeandale, Riley county.

In No. 1967 the abundant growth of mycelium caused the affected branches to assume an upright habit of growth like *Euphorbia maculata* L., when attacked by *Æcidium Euphorbiae* Persoon.

5. **Cystopus Amaranti** (S.) Berkeley.

On *Amarantus retroflexus* L.

1950, June 2, 1890, Manhattan; (the first specimen found; it was very rare); 1951, with mature oospores, on leaves, June 14, 1890, Manhattan (abundant); 1952, coll. M. Varney, July 15, 1890, Manhattan.

On **ACNIDA TUBERCULATA** Moq.

1953, coll. M. Varney, on leaves, July 5, 1890, Manhattan; 1954, coll. M. Varney, with mature oospores, on leaves, July 15, 1890, Manhattan; 1955, on leaves, August 20, 1890, Manhattan.

Cystopus Amaranti is more rare on this host at Manhattan than on either *Amarantus albus* or *A. blitoides*. It is very common on *Amarantus retroflexus*.

10. **Plasmopara Halstedii** (Farlow) Berlese & DeToni.

On *Ambrosia psilostachya* DC.

E. Bartholomew No. 348, July 27, 1889, Rockport, Rooks county.

On *Helianthus grosse-serratus* Martens.

1997, May 21, 1890, Manhattan.

On **BIDENS CHRYSANTHEMOIDES** Mich.

1996, June 3, 1890, Manhattan.

[1] Farlow, W. G., "Notes on Fungi. I," in The Botanical Gazette, Vol. XIV, No. 8, August, 1889, p. 188.

Page 68, line 24 from top, for Lev. read Lév.
" " " 5 " bottom, after 158, insert *with mature oospores.*
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PERONOSPORACEAE DE BARY.

1. Cystopus candidus (Pers.) Lév.

On *Sisymbrium canescens* Nutt.

1961, on leaves, March 24, 1890, Manhattan; 1962, on leaves, April 4, 1890, Manhattan; 1963, on leaves, April 28, 1890, Manhattan; 1964, on leaves, with abundant mature oospores in slightly swollen stems, May, 1890 (?). The date of collection of these valuable oospore-bearing specimens is unfortunately somewhat uncertain. The oospores agree very closely with the description and figures given by de Bary Rech. sur le développment de quelques champ. parasites, in An. Sci. Nat., série 4 t. XX, p. 131 (p. 126 of the reprint), Pl. 2, fig. 2–12.

On *Capsella Bursa-pastoris* Moench.

1965, collected by M. Varney, on leaves and stems, with abundant mature oospores in the swollen ends of the stems, and in distorted flowers, June, 1890, Manhattan.

On *Brassica nigra* Koch.

1956, with oospores in swollen stems, petioles and flowers, no conidia, July 7, 1890, Manhattan; 1957, with oospores only in swollen stems and flowers, July 31, 1890, Manhattan. This species was fully as abundant as in 1889, and likewise only oospores could be found when the specimens were collected. The oospores do not agree with the description and figures usually given of *Cystopus candidus*, being often more like those of a *Peronospora* of the *effusa* type. A few were furnished with a very finely warted epispore, but none were seen with the characteristic coarse warts found in typical specimens. It may be that the oospores, from being so crowded in the tissues of the parts attacked, stunted each other, since the host-plants themselves were much injured by drouth. The specimens collected July 4, 1887, (see list, p. 67,) had oospores showing the usual markings.

On *Lepidium intermedium* Gr.

1958, on leaves, April 4, 1890, Manhattan; 1959, on leaves, April 28, 1890, Manhattan; 1960, on leaves, May 8, 1890, Manhattan; 1998, on leaves of seedling plants, **OCTOBER** 19, 1890, Manhattan.

2. **Cystopus Ipomoeae-panduranae** (S.) Stevenson & Swingle.

On *Ipomoea hederacea* Jacq.

1966, on leaves, August 20, 1890, Manhattan.

In Seymour and Earle, Economic Fungi Fascicle I., January 1, 1890. No. 47. this species is given as *Cystopus Ipomoeae-panduranae* (S.) Farl. Farlow and Seymour, in their Provisional Host-Index of the Fungi of the United States, Part II. September, 1890, pp. 81 and 82, also give the name in this manner. Although Prof. Farlow said in August, 1889,[1] "Undoubtedly the first name given to the form on *Convolvulaceae* in North America was *Æcidium Ipomoeae-panduranae*," yet he nowhere actually called the species *Cystopus Ipomoeae-panduranae*. This was first done by Mr. W. C. Stevenson, jr., and myself in my list (p. 67, No. 2), which was published November 1, 1889; so the name should be given *Cystopus Ipomoeae-panduranae* (S.) Stevenson et Swingle.

3. **Cystopus Portulacae** (DC.) Lév.

On *Portulaca oleracea* L.

1967, July 12, 1890, Manhattan; Mr. E. Bartholomew, No. 236, on leaves, July [illegible] 1888, Rockport, Rooks county; 1970, coll. W. T. Allen, on leaves, August 13, [illegible] Manhattan; 1968, with abundant mature oospores, on leaves, August 20, [illegible] Manhattan; 1969, with abundant mature oospores, on leaves, August 20, [illegible] Zeandale, Riley county.

In No. 1967 the abundant growth of mycelium caused the affected branches to assume an upright habit of growth like *Euphorbia maculata* L., when attacked by *Æcidium Euphorbiae* Persoon.

5. **Cystopus Amaranti** (S.) Berkeley.

On *Amarantus retroflexus* L.

1950, June 2, 1890, Manhattan; (the first specimen found; it was very [illegible] with mature oospores, on leaves, June 14, 1890, Manhattan (abundant [illegible] coll. M. Varney, July 15, 1890, Manhattan.

On **ACNIDA TUBERCULATA** Moq.

1953, coll. M. Varney, on leaves, July 5, 1890, Manhattan; [illegible] with mature oospores, on leaves, July 15, 1890, Manhattan; [illegible] 20, 1890, Manhattan.

Cystopus Amaranti is more rare on this host at Manhattan than on either *Amarantus albus* or *A. blitoides*. It is very common on *Amarantus retroflexus*.

10. **Plasmopara Halstedii** (Farlow) Berlese & DeToni.

On *Ambrosia psilostachya* DC.

E. Bartholomew No. 348, July 27, 1889, Rockport, Rooks county.

On *Helianthus grosse-serratus* Martens.

1997, May 21, 1890, Manhattan.

On **BIDENS CHRYSANTHEMOIDES** Mich.

1996, June 3, 1890, Manhattan.

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[1] Farlow, W. G., "Notes on Fungi. I," in The Botanical Gazette, Vol. [illegible]

12. **Bremia Lactucae** Regel.

On *Lactuca Canadensis* L.

1971, June 1, 1890, Manhattan; 1600, June 18, 1889, Manhattan.

14. **Peronosporae Arenariae** (Berk.) Tul. var. **macrospora** Farl.

On *Silene antirrhina* L.

1975, with abundant mature **OOSPORES**, on leaves, **APRIL** 21, 1890, Manhattan; 1938, with abundant mature oospores, April 27, 1890, Manhattan.

Both of these numbers were collected on seedling plants growing in a wheat field. The presence of oospores in these specimens now renders certain their identity with the variety *macrospora* of Farlow, since the oospores agree exactly with the description given by him in "Additions to the Peronosporeae of the United States," in Botanical Gazette, Vol. IX, No. 3, March, 1884, p. 38, No. 12*. In all the specimens both oospores and conidia were abundant.

16. **Peronospora Arthuri** Farlow.

On *Œnothera sinuata* L.

1977, April 6, 1890, Manhattan.

16.* **PERONOSPORA CALOTHECA** de Bary.

1858 PERONOSPORA CALOTHECA de Bary in Rabenhorst, Klotzschii herb. viv. myc., Edit. 2, Cent. VII, No. 673; in Botanische Zeitung, XVI Jahrg. 1858, S. 58; Rech. s. l. dévelop. quelq. champ. par., in Ann. Sci. Nat., 4e sérié t. XX. caher No. 1, p. 112, (p. 107 of the extract); No. 9, Pl. 13, fig. 4, Berk. & Br., Ann. N. H., No. 1454; Cooke, British Fungi, in Grevillea, vol. III, No. 28, June, 1875, p. 183; Frank, Die Krankheiten der Pflanzen S. 410; Schroeter, Die Pilze Schlesiens I, S. 241, No. 362 (Cohn, Krypt. Flora Schles. III Bd. I. Hälfte.); Berlese et De-Toni in Saccardo, Sylloge Fungorum, vol. VII, Pars I, p. 245, No. 817.

1863 PERONOSPORA GALII Fuckel, Fungi rhenani exsic. Fasc. I, No. 30.

1863 PERONOSPORA SHERARDIAE Fuckel, Fungi rhenani exsic. Fasc. I, No. 31.

Conidia and oospores on leaves of *Rubiaceae*, April.

On *Galium Aparene* L.

1939, with mature oospores, on leaves, April 27, 1890, Pottawatomie county, northwest of St. George.

This species found this spring for the first time within the State, was abundant on some seedling *Galium* growing along an old fence. The oospores were found in the oldest leaves attacked, and agreed very closely with the description and figures given by de Bary.

17. **Peronospora Oxybaphi** Ellis & Kellerman.

On *Oxybaphus nyctagineus* Sweet.

1985, May 8, 1890, Manhattan; 1986, May 26, 1890, Manhattan.

18. **Peronospora Corydalis** de Bary.

On *Corydalis aurea* Willd., var. *occidentalis* Engelm.

1980, on leaves, April 21, 1890, Manhattan; 1581, with mature oospores, on leaves, April 27, 1890, Manhattan; 1688, with abundant mature oospores, on leaves, stems and inflorescences, May 16, 1889, Manhattan; 1999, with abundant mature oospores, on leaves, **JUNE** 9, 1888, Manhattan.

19. **Peronospora parasitica** (Persoon) Fries.

On *Sisymibrium* sp.

1992, on leaves, April 6, 1890, Manhattan.

On *Lepidium intermedium* Gr.

1987, on leaves, April 4, 1890, Manhattan; 1988, on leaves, April 28, 1890, Manhattan; 1989, on leaves, May 8, 1890, Manhattan.

24. **Peronospora alta** Fuckel.

On *Plantago Rugelii* Decaisne.

1972, coll. M. Varney, May 26, 1890, Manhattan; 1973, June 1, 1890, Manhattan; 1974, with mature oospores, **OCTOBER** 25, 1890, Manhattan.

25. **Peronospora candida** Fuckel.

On *Audrosace occidentalis* Ph.

1979, with abundant mature oospores, April 6, 1890, Manhattan.

26. **Peronospora grisea** Unger.

On *Veronica peregrina* L.

1984, with mature **OOSPORES**, June 1, 1890, Manhattan.

28. **Peronospora Swinglei** Ellis & Kellerman.

On *Salvia lanceolata* Willd.

1976, on leaves and stems, **JULY** 3, 1887, Manhattan.

29. **Peronospora effusa** (Greville) Rabenhorst.

On *Chenopodium album* L., var. *viride.*

1982, **APRIL** 27, 1890, Pottawatomie county, northwest of St. George; 1983, coll. M. Varney, May 26, 1890, Manhattan.

30. **Peronospora Rumicis** Corda.

On *Polygonum dumetorum* L., var. *scandens* Gray.

1991, with mature **OOSPORES**, on leaves, **JUNE** 1, 1890, Manhattan; 1990, coll. M. Varney and W. T. Swingle, with mature oospores, on leaves, June 2, 1890, Manhattan.

This rather rare species was found this year in considerable quantity on plants growing in shady woods, on the old site of a creek-bed. The oospores were quite abundant in the oldest yellow or brown leaves, but could not be found on the bright green leaves bearing conidiaphores. The oospores are 30 to 40 μ diam., with a brown epispore which is very irregularly ridged or folded, giving the oospores a star-like appearance in optical section. The oogonia are shriveled and difficult to see clearly. The epispore varies in thickness from 2 to 10 μ.

31. **Peronospora Euphorbiae** Fuckel.

On *Euphorbia glyptosperma* Engelm.

1994, coll. W. T. Allen, with mature oospores, on leaves, August 5, 1890, Manhattan.

Prof. Byron D. Halsted says [1] "Peronospora Euphorbiae, Fckl., is a species which quickly disappears in times of drought." This summer has been a very dry one, and during a very dry time *Peronospora Euphorbiae* was collected in quantity on *Euphorbia glyptosperma* growing on some dry, sandy hills. At the same time a very little *Cystopus Portulacae* was observed on *Portulaca obracea* growing in a neighboring corn-field. Aside from these two species the Peronosporaceae had disappeared,

[1] Halstead, Byron D., Downy Mildews in a Dry Season, in Bull. from the Botanical Department of the State Agricultural College, Ames, Iowa, February, 1888, p. 98; Peronosporeae and Rainfall, in *Journal of Mycology*, vol. 5, No. 1, March, 1889, p. 9.

excepting *Cystopus candidus* in the oospore-bearing distortions on *Brassica nigra*. But the oospores, after once being formed (during May and June?), could, of course, endure any kind of weather. These facts would go to show that under some conditions at least *Peronospora Euphorbiae* should be classed as a drought-resisting species. It is an interesting fact that during dry or otherwise unfavorable times, the various species of Peronosporace disappear entirely from their rarer hosts and attack, to a lessened degree, only their most common hosts. For instance, here *Peronospora Euphorbiae* is found on *Euphorbia hypericifolia* only during favorable Peronospora weather, and then only in small quantity. During dry weather I have as yet failed entirely to find it on this host. These facts might indicate a closer adaptation of the Peronospora for some hosts than for others, and hence, under unfavorable conditions, only those hosts would be attacked to which the parasite was most perfectly adapted. Of course, in some cases, the habitat (on high, dry land for instance) of the supporting plant might hinder the spread of the parasite, although the parasite were perfectly adapted to its host.

32. **Peronospora sordida** Berkeley.

On *Scrophularia nodosa* L.

1993, June 2, 1890, Manhattan.

Including the additions given in this paper, there are now known from Kansas 33 species of Peronosporaceae, on 71 different host plants, entering the hybrid varieties of cultivated grape as 1 species. 70 of these host plants are dicotyledonous phanerogams, and 1 (Setaria) a monocotyledonous phanerogam. 31 species on 67 host plants occur within a radius of ten miles from Manhattan, Kansas.

ON THE GERMINATION OF INDIAN CORN AFTER IMMERSION IN HOT WATER.

BY W. A. KELLERMAN, PH. D.

Numerous trials were made in July and August to determine the germination of Indian corn after immersion for one-third of a minute to twenty minutes in water ranging in temperature from 56° C. (132.8° F.) to 88½° C. (199° F.).

The temperature of the water in the vessel was kept, during the immersion of the grain, at the desired temperature by addition of cooler or warmer water as required.

After immersion the grain was plunged into cold water in order to cool it rapidly. While in the vessel of hot or cold water, the wire basket containing the grain was given repeatedly a whirling and a plunging motion, so that every grain might surely be subjected to water of the same temperature the entire time of immersion.

After the above treatment the grain was at once planted, either in a Geneva tester kept indoors, or in the ground. The results of the germinations are given in the extended tabulation below.

The varieties of corn used were St. Charles and Normandy Giant (*white*), Leaming and Murdock's (*yellow*), Thoroughbred *Flint*, Mason's flour corn (*soft*), Shakers Early *Sweet* and *Pop* corn. The change from St. Charles to Normandy Giant, and from Leaming to Murdock's, was necessitated by insufficient quantity of the first variety in each case, but the germinative capacity was tested in each case and they were found to be identical. Therefore, the results are not vitiated by this enforced change.

The grains in the tester germinated in two or three days, but usually six or seven

days elapsed before they were counted out of the same. No grains, therefore, were included in the non-germinating lot except those that really belonged there.

The first germinations in the ground were unsatisfactory, on account of the drouth that prevailed in early summer, and were wholly abandoned. But later they were repeated, and their number can be seen by consulting the tabulation. In the second set of trials the germinations were not entirely satisfactory, due to climatic and other conditions.

In many cases the grain was soaked, previous to treatment, from a few to 22 hours, in water of the ordinary temperature at that season of the year. The experiments show, in each case, that water of the higher temperatures decreases or destroys their germinative power much more quickly than in case of grains not thus thoroughly soaked. For example: In case of immersion of five minutes in water at a temperature of 70° C. (158° F.) the germination (of the white variety in the tester) was 98 per cent.; and when previously soaked 8 hours (as well as for 22 hours) it was zero—*i. e.*, in the latter case not a single grain germinated.

The difference in favor of non-soaked corn, however, is obliterated when the comparatively low temperatures obtain—as seen in the tabulation opposite 58° C (136.4° F.), etc.

Numerous control experiments were made at the same time with grains not heated with hot water. The results of these (combined) are shown in the last eight lines of the table.

Owing to the large size of the grains it was impracticable to use more than about 50 in each trial, yet the four or six repetitions (with different varieties) for each degree C. and the wide range compassed, namely, 88½ (199° F.) down to 56° C. (132.8° F.), partially compensate for the probable variation in percentage of germination for so few grains taken.

It will be noticed that a very high degree of temperature, *e. g.*, 88½° C. (199° F.), usually kills less than half of the seeds when the immersion is prolonged to 20 seconds.

An immersion of one minute in water at 81° C. (177.8° F.) kills comparatively few grains, but if previously soaked 18 hours all are killed.

An immersion of three minutes, to be comparatively harmless, must be in water at or less than 76 or 75° C. (168.8° to 167° F.). But here, as above, it is fatal if the grain has been previously soaked for several hours.

An immersion of five minutes, to secure a result approximately similar to the last, must be in water at 73° or 72° C. (163.4° to 161.6° F.).

The immersion can be prolonged, without detriment to the (previously dry) seed, ten or fifteen minutes provided the water is at a temperature of about 59° C. (138.2° F.), or less.

Similar trials with wheat and oats, carried on in connection with work of the Experiment Station of the State Agricultural College. show that these grains endure approximately the same temperatures with similar results. Besides, immersion of the seeds of these two cereals in water at a temperature of about 57° C. (or 134° F.), proved to be *an efficient fungicide* for wheat smut and oat smut.

The general results with the varying temperature and time of immersion, as well as the generally poorer germination in the ground than in the tester, can easily be seen from the table which here follows:

TABLE OF GERMINATION.

DEGREES.		Time, in minutes.	WHERE GERMINATED.	WHITE.			YELLOW.			FLINT.			SOFT.			SWEET.			POP.			REMARKS.
C.	F.			No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	
88½	199.15	½	In tester	49	38	77½	50	34	68	50	25	50	50	28	56							
88½	"	½	In ground	50	19	38	50	15	30	50	16	32	50	12	24							
84	183.2	1	In tester	50	39	78	50	44	88	38	34	89½	50	43	86							
84	"	1	In ground	50	29	58	50	44	88	50	42	84	50	29	58							
81	177.8	1	In tester	50	40	80	50	46	92	50	40	80	50	45	90							
81	"	1	In ground	50	5	10	50	7	14	50	17	34	50	9	18							
81	"	1	In tester	50	0	0	50	0	0	50	0	0	50	0	0							Soaked 18 hours.
81	"	1	In ground	50	0	0	50	0	0	50	0	0	50	0	0							Soaked 18 hours.
81	"	2	In tester	48	8	16½	50	9	18	50	10	20	50	17	38							
81	"	2	In ground	50	0	0	50	1	2	50	0	0	50	0	0							
81	"	2	In tester	50	0	0	50	0	0	50	0	0	50	0	0							Soaked 18 hours.
81	"	2	In ground	50	0	0	50	0	0	50	0	0	50	0	0							Soaked 18 hours.
80	176.0	3	In tester	50	1	2	50	0	0	50	0	0	50	0	0							
80	"	3	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
80	"	5	In tester	50	0	0	50	0	0	50	0	0	50	0	0							
80	"	5	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
79	174.2	3	In tester	50	0	0	50	0	0	50	0	0	50	0	0							
79	"	3	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
79	"	5	In tester	50	0	0	50	0	0	50	0	0	50	0	0							
79	"	5	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
78	172.4	3	In tester	50	0	0	50	9	18	50	10	20	50	0	0							
78	"	3	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
78	"	5	In tester	50	0	0	50	0	0	50	0	0	50	0	0							
78	"	5	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
77	170.6	3	In tester	50	16	32	50	18	36	50	36	72	50	18	36							
77	"	3	In ground	50	0	0	50	0	0	50	8	16	50	0	0							
77	"	5	In tester	50	0	0	50	0	0	50	0	0	50	0	0							
77	"	5	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
76	168.8	3	In tester	50	33	66	50	39	78	50	42	84	50	30	60							
76	"	3	In ground	50	0	0	50	2	4	50	6	12	50	1	2							
76	"	5	In tester	50	9	18	50	9	18	50	30	60	50	7	14							
76	"	5	In ground	50	0	0	50	0	0	50	0	0	50	0	0							
75	167	3	In tester	50	36	72	50	37	74	50	46	92	50	31	62							
75	"	3	In ground	50	1	2	50	9	18	50	16	32	50	0	0							
75	"	5	In tester	43	28	65	33	22	66½	28	21	75	48	32	66½							
75	"	5	In ground	50	0	0	50	0	0	50	1	2	50	0	0							
74	165.2	3	In tester	50	42	84	50	44	88	50	45	90	50	44	88							
74	"	3	In ground	50	3	6	50	17	34	50	38	76	50	1	2							
74	"	5	In tester	43	28	65	33	22	66½	28	21	75	48	32	66½							

74	165.2	5	In ground.....	50	0	**0**	50	4	**8**	50	9	**18**	50	0	**0**	.....	.....	.....	.....	.....	.....	———
73	163.4	1	In tester.....	50	49	**98**	50	48	**96**	50	48	**96**	50	48	**96**	50	38	**76**	50	48	**96**	———
73	"	2	In tester.....	59	51	**86½**	50	46	**92**	59	54	**83**	50	50	**100**	50	32	**64**	50	49	**98**	———
73	"	3	In tester.....	80	67	**83⅓**	100	87	**87**	99	95	**96**	102	96	**94**	50	30	**60**	50	33	**66**	———
73	"	3	In ground.....	50	16	**32**	50	24	**48**	50	23	**46**	50	9	**18**	.....	.....	.....	.....	.....	.....	———
73	"	3	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
73	"	3	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
73	"	3	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
73	"	3	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
73	"	5	In tester.....	50	38	**76**	50	39	**78**	50	41	**82**	48	21	**43½**	.....	.....	.....	.....	.....	.....	———
73	"	5	In ground.....	50	0	**0**	50	4	**8**	50	9	**18**	50	0	**0**	.....	.....	.....	.....	.....	.....	———
73	"	5	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
73	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
73	"	5	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
73	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
72	161.6	1	In tester.....	50	44	**88**	50	48	**96**	50	39	**78**	50	46	**92**	50	38	**76**	50	47	**94**	———
72	"	1	In ground.....	50	23	**46**	50	32	**64**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
72	"	2	In tester.....	50	39	**78**	50	48	**96**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
72	"	2	In ground.....	50	23	**46**	50	23	**46**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
71	159.8	1	In tester.....	50	46	**92**	50	45	**90**	50	42	**84**	50	46	**92**	50	44	**88**	50	48	**96**	———
71	"	2	In tester.....	50	45	**90**	50	49	**98**	50	47	**94**	50	43	**86**	50	33	**66**	50	41	**62**	———
71	"	2	In ground.....	50	23	**46**	50	33	**66**	.....	.....	.....	50	35	**70**	50	5	**10**	50	17	**34**	———
70	158.0	1	In tester.....	50	49	**98**	50	49	**98**	50	48	**96**	50	48	**96**	50	40	**80**	50	41	**82**	———
70	"	2	In tester.....	50	46	**92**	50	48	**96**	50	40	**80**	50	48	**96**	50	37	**74**	50	46	**92**	———
70	"	2	In ground.....	50	16	**32**	50	35	**70**	100	64	**64**	50	33	**66**	50	20	**40**	50	35	**70**	———
70	"	3	In tester.....	100	88	**88**	100	97	**97**	99	86	**87**	90	84	**93½**	50	37	**74**	50	45	**90**	———
70	"	3	In ground.....	100	22	**22**	100	44	**44**	100	47	**47**	100	46	**46**	50	0	**0**	50	32	**64**	———
70	"	3	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
70	"	3	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
70	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
70	"	5	In tester.....	50	49	**98**	50	34	**68**	50	45	**90**	50	48	**96**	49	25	**51**	49	39	**79½**	———
70	"	5	In ground.....	50	38	**76**	50	39	**78**	.....	.....	.....	50	32	**64**	.....	.....	.....	.....	.....	.....	———
70	"	5	In tester.....	50	0	**0**	50	0	**0**	50	1	**2**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
70	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 8 hours.
70	"	5	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
70	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
69	156.2	3	In tester.....	48	39	**81¼**	50	50	**100**	50	50	**100**	50	50	**100**	.....	.....	.....	.....	.....	.....	———
69	"	3	In ground.....	50	39	**78**	50	50	**100**	50	48	**96**	25	23	**92**	.....	.....	.....	.....	.....	.....	———
69	"	5	In tester.....	50	44	**88**	50	50	**100**	50	47	**94**	50	46	**92**	.....	.....	.....	.....	.....	.....	———
69	"	5	In ground.....	50	28	**56**	50	37	**74**	50	38	**76**	50	16	**32**	.....	.....	.....	.....	.....	.....	———
68	154.4	1	In tester.....	50	50	**100**	50	50	**100**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
68	"	1	In ground.....	50	45	**90**	50	36	**72**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
68	"	2	In tester.....	50	50	**100**	50	47	**94**	50	47	**94**	50	50	**100**	50	47	**94**	50	49	**98**	———
68	"	2	In ground.....	50	36	**72**	50	43	**86**	50	41	**82**	50	31	**62**	50	16	**32**	50	43	**86**	———
67	151.6	1	In tester.....	50	5	**10**	50	0	**0**	50	8	**16**	50	2	**4**	50	1	**2**	50	0	**0**	Soaked 10½ hours.
67	"	3	In tester.....	50	0	**0**	50	0	**0**	50	1	**2**	41	0	**0**	50	0	**0**	50	0	**0**	———
66	150.8	5	In tester.....	50	49	**98**	50	48	**96**	50	48	**96**	50	50	**100**	50	43	**86**	50	48	**96**	———
66	"	5	In ground.....	50	38	**76**	50	42	**84**	50	29	**58**	50	46	**92**	50	20	**40**	50	31	**62**	———
66	"	15	In tester.....	50	47	**94**	51	26	**51**	50	49	**98**	50	36	**72**	50	18	**36**	50	23	**46**	———
65	149.0	3	In tester.....	50	50	**100**	50	47	**94**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
65	"	3	In ground.....	50	3	**6**	50	3	**6**	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	———
65	"	5	In tester.....	00	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.

TABLE OF GERMINATION—CONCLUDED.

DEGREES.		Time, in minutes.	WHERE GERMINATED.	WHITE.			YELLOW.			FLINT.			SOFT.			SWEET.			POP.			REMARKS.
C.	F.			No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	No. grains	No. germinated	Per cent. germinated	
65	149.0	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
65	"	10	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
65	"	10	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
64	147.2	5	In tester.....	50	50	**100**	96	92	**96**	92	87	**94½**	50	50	**100**	50	46	**92**	50	50	**100**	———
64	"	5	In ground.....	100	65	**65**	100	70	**70**	100	80	**80**	100	77	**77**	50	7	**14**	50	33	**66**	———
64	"	5	In tester.....	98	47	**48**	100	50	**50**	100	50	**50**	.....	.....	.....	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
64	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
64	"	10	In tester.....	50	50	**100**	50	50	**100**	50	50	**100**	50	46	**92**	50	43	**86**	50	47	**94**	———
64	"	10	In ground.....	100	39	**39**	100	51	**51**	100	50	**50**	100	31	**31**	50	2	**4**	50	12	**24**	———
64	"	10	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
64	"	10	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
64	"	15	In tester.....	50	49	**98**	49	47	**96**	50	45	**90**	50	50	**100**	50	28	**56**	50	47	**94**	———
63	145.4	5	In tester.....	100	96	**96**	100	99	**99**	100	99	**99**	50	49	**98**	50	42	**84**	1	.....	.....	———
63	"	5	In ground.....	50	29	**58**	50	36	**72**	50	43	**86**	50	39	**78**	51	38	**66½**	50	41	**82**	———
63	"	5	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
63	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
63	"	10	In tester.....	50	47	**94**	100	98	**98**	50	50	**100**	98	98	**100**	.....	.....	.....	.....	.....	.....	———
63	"	10	In ground.....	50	36	**72**	50	34	**68**	50	15	**30**	50	29	**58**	.....	.....	.....	.....	.....	.....	———
63	"	10	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
63	"	10	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
62	143.6	5	In tester.....	50	47	**94**	50	49	**98**	50	50	**100**	50	49	**98**	.....	.....	.....	.....	.....	.....	———
62	"	5	In ground.....	50	35	**70**	50	43	**86**	50	34	**68**	50	42	**84**	.....	.....	.....	.....	.....	.....	———
62	"	5	In tester.....	50	6	**12**	50	4	**8**	50	3	**6**	50	2	**4**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
62	"	5	In ground.....	50	5	**10**	50	4	**8**	50	0	**0**	50	4	**8**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
62	"	5	In tester.....	50	0	**0**	50	2	**4**	50	1	**2**	50	1	**2**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
62	"	5	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	1	**2**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
62	"	10	In tester.....	50	48	**96**	50	49	**98**	50	46	**92**	50	49	**98**	.....	.....	.....	.....	.....	.....	———
62	"	10	In ground.....	50	32	**64**	50	34	**68**	50	23	**46**	50	32	**64**	.....	.....	.....	.....	.....	.....	———
62	"	10	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	6	**0**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
62	"	10	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
62	"	10	In tester.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
62	"	10	In ground.....	50	0	**0**	50	0	**0**	50	0	**0**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
61	141.6	5	In tester.....	50	48	**96**	50	50	**100**	50	48	**96**	50	49	**98**	50	47	**94**	50	50	**100**	———
61	"	5	In ground.....	50	39	**78**	50	40	**80**	50	38	**76**	50	44	**88**	50	21	**42**	50	34	**68**	———
60	140.0	3	In tester.....	50	47	**94**	50	46	**92**	50	48	**96**	50	43	**96**	50	48	**96**	50	50	**100**	———
60	"	3	In ground.....	50	33	**66**	50	40	**80**	50	39	**78**	50	31	**62**	50	16	**32**	50	32	**64**	———
60	"	5	In tester.....	100	91	**91**	104	103	**99**	100	94	**94**	100	96	**96**	100	82	**82**	100	99	**99**	———
60	"	5	In ground.....	50	10	**20**	50	46	**92**	50	42	**84**	50	36	**72**	50	13	**26**	50	40	**80**	———
60	"	5	In tester.....	50	16	**32**	50	15	**30**	50	14	**28**	50	5	**10**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.

60	140.0	5	In ground.....	50	22	**44**	50	26	**32**	50	13	**26**	50	24	**48**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
60	"	10	In tester.....	50	50	**100**	50	46	**98**	50	43	**86**	50	47	**94**	50	39	**78**	50	50	**100**	——— [water.
60	"	10	In tester.....	52	42	**81**	50	49	**98**	50	50	**100**	50	49	**98**	50	40	**80**	50	49	**98**	Immersed in cold
60	"	10	In tester.....	50	2	**4**	50	2	**4**	50	2	**4**	50	0	**0**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
60	"	10	In ground.....	50	9	**18**	50	9	**18**	50	1	**2**	50	3	**6**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
59	138.2	3	In tester.....	50	48	**96**	50	49	**98**	50	44	**88**	50	46	**92**	.....	.....	.....	.....	.....	.....	———
59	"	3	In ground.....	50	45	**90**	50	49	**98**	50	45	**90**	50	48	**96**	.....	.....	.....	.....	.....	.....	———
59	"	5	In tester.....	.....	.....	.....	.....	.....	.....	32	24	**75**	50	47	**94**	.....	.....	.....	.....	.....	.....	———
59	"	5	In ground.....	50	46	**92**	50	40	**80**	50	47	**94**	50	46	**92**	.....	.....	.....	.....	.....	.....	———
59	"	10	In tester.....	50	35	**70**	50	42	**84**	50	47	**94**	50	49	**98**	.....	.....	.....	.....	.....	.....	———
59	"	10	In ground.....	50	43	**86**	50	29	**58**	50	42	**84**	50	42	**84**	.....	.....	.....	.....	.....	.....	———
58	136.4	3	In tester.....	50	49	**98**	50	47	**94**	50	50	**100**	50	49	**98**	50	47	**94**	50	49	**98**	Soaked 6 hours.
58	"	3	In ground.....	57	40	**80**	50	39	**78**	50	29	**58**	50	35	**70**	50	12	**24**	50	15	**30**	Soaked 6 hours.
58	"	5	In tester.....	50	50	**100**	50	50	**100**	50	50	**100**	50	49	**98**	50	44	**88**	50	49	**98**	———
58	"	5	In ground.....	50	37	**74**	50	36	**72**	50	33	**66**	50	38	**76**	50	13	**26**	50	34	**68**	———
58	"	5	In tester.....	50	49	**8**	49	48	**98**	50	50	**100**	50	50	**100**	50	38	**76**	50	45	**90**	Soaked 6 hours.
58	"	5	In ground.....	50	18	**36**	50	27	**54**	50	32	**64**	50	31	**62**	50	7	**14**	50	42	**84**	Soaked 6 hours.
58	"	5	In tester.....	50	27	**54**	50	21	**42**	50	16	**32**	50	22	**44**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
58	"	5	In ground.....	50	40	**80**	50	33	**66**	50	42	**84**	50	23	**46**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
58	"	10	In tester.....	50	48	**96**	50	50	**100**	50	48	**96**	50	50	**100**	50	30	**60**	49	40	**82**	Soaked 6 hours.
58	"	10	In ground.....	50	24	**48**	50	43	**86**	20	11	**55**	17	17	**100**	33	1	**3**	50	15	**30**	Soaked 6 hours.
58	"	10	In tester.....	50	20	**40**	50	18	**36**	50	21	**42**	50	19	**38**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
58	"	10	In ground.....	50	42	**84**	50	24	**48**	50	30	**60**	50	29	**58**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
57	134.6	5	In tester.....	50	49	**98**	50	48	**96**	50	50	**100**	50	47	**94**	50	49	**98**	50	50	**100**	———
57	"	5	In ground.....	50	42	**84**	50	40	**80**	50	38	**76**	50	33	**66**	50	16	**32**	50	42	**84**	———
57	"	10	In tester.....	50	48	**96**	50	48	**96**	50	48	**96**	50	49	**98**	50	46	**92**	50	49	**98**	———
57	"	10	In ground.....	50	42	**84**	50	29	**58**	50	50	**100**	50	33	**66**	50	31	**62**	50	34	**68**	———
57	"	15	In tester.....	50	49	**98**	50	40	**80**	50	49	**98**	50	49	**98**	50	48	**96**	50	50	**100**	———
57	"	15	In ground.....	50	44	**88**	50	19	**38**	50	28	**56**	50	40	**80**	50	9	**18**	50	38	**76**	———
57	"	20	In tester.....	50	49	**98**	50	50	**100**	50	47	**94**	50	50	**100**	50	45	**90**	50	46	**92**	———
57	"	20	In ground.....	50	28	**56**	50	2	**4**	50	35	**70**	50	23	**46**	50	9	**18**	50	15	**30**	———
56	132.8	10	In tester.....	50	49	**98**	50	50	**100**	50	47	**94**	50	49	**98**	.....	.....	.....	.....	.....	.....	———
Untreated.....			In tester.....	300	290	**96⅛**	304	291	**95⅛**	299	265	**88¼**	300	296	**98⅛**	201	170	**84⅛**	200	191	**93**	———
Untreated.....			In ground.....	300	220	**73⅜**	299	207	**69**	300	211	**70**	300	224	**74⅝**	200	75	**37⅛**	152	114	**75**	———
Untreated.....			In tester.....	50	49	**98**	50	49	**98**	50	46	**92**	50	50	**100**	.....	.....	.....	.....	.....	.....	Soaked 12 hours.
Untreated.....			In ground.....	50	46	**92**	50	49	**98**	50	48	**96**	50	45	**90**	.....	.....	.....	.....	.....	.....	Soaked 14 hours.
Untreated.....			In tester.....	50	50	**100**	50	50	**100**	50	48	**96**	50	47	**94**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
Untreated.....			In ground.....	50	49	**98**	50	43	**86**	50	45	**90**	50	49	**98**	.....	.....	.....	.....	.....	.....	Soaked 18 hours.
Untreated.....			In tester.....	50	47	**94**	50	50	**100**	50	50	**100**	50	49	**98**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.
Untreated.....			In ground.....	50	48	**96**	50	46	**92**	50	48	**96**	50	46	**92**	.....	.....	.....	.....	.....	.....	Soaked 22 hours.

OBSERVATIONS ON THE NUTATION OF SUNFLOWERS.

BY W. A. KELLERMAN, PH.D., AGR. COLLEGE, MANHATTAN, KAS.

It is a common and apparently almost universal belief, that the sunflowers turn with the sun; that is to say, that the disk is turned in the morning toward the east, and that it slowly moves southward until noon, and then westward till night, keeping pace with the apparent motion of the sun. This belief in case of most people rests, so far as I can determine by inquiry, not so much on direct observation as on hints and assertions of others. It is, in fact, mainly traditional.

That there is some movement, has undoubtedly been observed by very many, but how general and extensive in scope it is, is less accurately known. To determine this point for my own satisfaction, I undertook the past season to make a careful record of observations on the commonest of our native sunflowers, namely, *Helianthus annuus*, which is considered to be identical with the commonly-cultivated species. These observations are recorded in tabular form below.

The record, commenced September 2, was interrupted September 4, 5, and 6. It was resumed September 7, and continued until September 17.

The observations were made usually between seven and eight o'clock in the morning, and between five and six in the evening. When the wind was very strong, so as to interfere with the normal position of the heads, no observations were recorded. Following the tabulation will be found a record of the daily direction of the wind.

The plants observed, forty in number, were for the most part in a small, nearly level pasture field. A few of them were near trees, but the position of each plant is stated in the tabulation below. Some of them had but a single head, the majority had several, and one plant had thirty-five heads. They were of various heights, ranging from sixteen inches to eleven feet.

No compass was used in determining directions, but as the fences around the field were exactly east and west and north and south, it is not presumed that many grave errors were made. The directions noted were north, south, east, west, northeast, southeast, northwest, southwest, north-northeast, east-northeast, east-southeast, south-southeast, north-northwest, west-northwest, south-southwest, west-southwest, and all of the points between those already named (as north by east, north by northeast, etc.), making thirty-two in all, or twelve and one-half degrees between each. It is then plain that the slightest movement detectable without an instrument could be recorded.

Before proceeding to an analysis of the table, it might be stated that observations were made Sept. 9, on *Helianthus rigidus*. About 110 heads of exposed plants occupying a very small area by the roadside were counted at 9 A. M. It was found that nearly all of them were turned southeast upward; a few were directed eastward, and a few southward. At 6 P. M. they were again carefully observed, when it was found that most of the heads had turned slightly more southward.

A similar count was made of blooming heads of *Helianthus annuus* near the preceding cluster on the same day (Sept. 9). Four hundred and twenty heads were counted in the morning, and five hundred in the evening. No note was taken of directions between the cardinal points of the compass; those heads were therefore omitted that were exactly between these points, but all others were included. The result of these two counts is as follows:

	MORNING.		EVENING.	
Heads turned toward the	East.....	158, or 37.62%	East.....	179, or 35.80%
	South.....	133, or 31.66%	South....	168, or 33.60%
	West.....	58, or 13.80%	West.....	104, or 20.80%
	North.....	71, or 16.90%	North.....	54, or 10.80%

The indication from the above is that during the day but two to seven per cent of the heads turn from any given point through 90°. But there may be movements through an arc of much smaller dimensions, and these are, of course, not here indicated. Such movements are, however, shown in the tabulation below.

It can be seen, upon cursory examination of the tables below, that, as a rule, the heads while in bloom, move from morning to night, and from night to morning, through only a very small space — that but few move through a space approaching a half-circle, and in many cases there is no perceptible movement at all.

SUMMARY OF THE TABLE OF OBSERVATIONS.

Total number of heads observed	328
Total number cases of observations recorded	1,840
Total number cases of movements of heads	1,214, or 66%
Total number cases of no movement	626, or 44%

SUMMARY OF THE 1,840 CASES RECORDED.

DAY.		NIGHT.	
Movements West	436, or 23.70%	Movements East	401, or 21.79%
Movements East	152, or 8.26%	Movements West	158, or 8.58%
Movements up	15, or 0.82%	Movements up	14, or 0.76%
Movements N. to S	11, or 0.60%	Movements N. to S	9, or 0.49%
Movements S. to N	9, or 0.49%	Movements S. to N	9, or 0.49%
No movements	243, or 13.20%	No movements	383, or 20 81%

SUMMARY OF THE 1,214 HEADS THAT MOVED.

DAY.		NIGHT.	
Movements West	436, or 69.98%	Movements East	401, or 67.88%
Movements East	152, or 24.40%	Movements West	158, or 26.74%
Movements up	15, or 2.41%	Movements up	14, or 2.38%
Movements N. to S	11, or 1.77%	Movements N. to S	9, or 1.51%
Movements S. to N	9, or 1.44%	Movements S. to N	9, or 1.51%

It might be added, finally, that the heads were rarely observed (in reference to nutation) unless at least a few of the florets were in anthesis, and the observations were continued in most cases until the last of the florets were in full bloom.

It is likely that nutation is more marked in the head previous to anthesis, but this question was not regarded.

The tabulation needs no explanation, except to say that the uppermost head is given in the first column, after the date and time of day, that the outermost head of successive branches passing downward are numbered in serial order, and that second or third heads, etc., on the branches, are indicated by added numerals in smaller type.

No. 1.—Thirty-three inches high; poplar trees two-thirds of a rod east; maple grove two rods south; plant isolated.

September.	Time.	Upper.	2	3	4
2	A M.	S			
2	M.	N			
2	P M.	N by NW			
3	A M.	N	NW		
3	P M.	N	N		
7	A M.	N	NNE	NNW	WNW
7	P M.	N	NNE	NNW	W by NW
8	A M.	N	NNE	N by NW	up S
8	P M.		NNE	NW	WNW
9	A M.		NNE	NNW	NW
9	P M.		NNE	NNW	NW
10	A M.		Destroyed.	Destroyed.	Destroyed.

No. 2.—Four and one-half feet high; in pasture field, isolated.

Sept.	Time.	Upper.	2	4	4^2	5	8	8^2	10	10^2	5^2
2	A M	NW									
2	M	NE	NE								
2	P M	S	up N								
3	A M	SE	NE	S by SE							
3	P M	E	NE	up							
7	A M	Destr.	Destr.	Destr.		ESE	S by SW		SW		
7	P M					ESE	S by SW		SW		
8	A M					ESE	S by SE		ESE		
8	P M					SE	S by SW		SE		
9	A M					E by SE	S by SE		ESE		
9	P M					E by SE	S		ESE		
10	A M				up NNE	E by SE	S		ESE		up SE
10	P M				up NE			up		up W	up N
11	A M				up W				up		up ESE
11	P M				W			up W		up	up N
12	A M				NNW			up S		up	SSW
13	A M				W			SW		up E	Destr.
13	P M				NW			WSW		up	
14	A M				up NW			up W		up	
15	A M				up			up		up	
15	P M				up			up		up	
16	A M				up			up		up	
16	P M				up W			up S		up	
17	A M				up			up S		up	
17	P M				up NW			up		up	

No. 2—Concluded:

Sept.	Time.	11	11^2	13	14	15	16	17	18
2	A M.								
2	M.								
2	P M.								
3	A M.								
3	P M.								
7	A M.	SE		SSE		NE	ENE	up W by SW	
7	P M.	up SE		up SE	up SSE	NNE	up N	up NW	
8	A M.	SE		SE	up SW	NE	up E	up	
8	P M.	SE		SE	up SE	NE	NE	NW	
9	A M.	SE		ESE	up SW	NE	NE	WNW	
9	P M.	SE		ESE	up SW	NE	NE	NNW	E
10	A M.	SE		ESE	up SW	NE	up E by NE	up	ESE
10	P M.		up S	ESE	up SSW		NE	NW	ENE
11	A M.		up		up SW				ENE
11	P M.		up SW						ESE
12	A M.		up						E by SE
13	A M.		up SW						E by SE
13	P M.		up						
14	A M.		up						
15	A M.		up						
15	P M.		up						

No. 3.—Twenty-six inches high; poplar tree three and one-half rods east.

September.	Time.	Upper.
3	A M	N
3	P M	NW

No. 4.—Four feet and two inches high; poplar tree one rod east.

Sept.	Time.	Upper.	2	3
3	A M	N by NW	NW	
3	P M	NW	NW	
7	A M	SW	W	S
7	P M	WSW	SW	S
8	A M	SW	W by SW	S
8	P M	SW	W by SW	SW
9	A M	SW	WSW	SSW
9	P M		WSW	SW
10	A M			SSW
10	P M			SSW

No. 5.—Thirty inches high; poplar tree two-thirds of a rod east.

Sept.	Time.	Upper.	2
3	A M	W by NW	
3	P M	NW	
7	A M	WSW	WSW
7	P M	WSW	SW
8	A M	WSW	WSW
8	P M	W	W by SW
9	A M	W	W
9	P M	W	W
10	A M		W
10	P M		W

No. 6.—Twenty-five inches high; poplar tree one-half rod east.

Sept.	Time.	Upper.
3	A M	SE
3	P M	S
7	A M	SW
7	P M	WSW
8	A M	SW
8	P M	SW
9	A M	SW
9	P M	SW

No. 7.—Four feet high: inclining strongly toward northwest; poplar trees one rod east.

Sept.	Time.	Upper.	2	3	4
3	A M	NW	N	NW	
3	P M	WNW	WNW	WNW	
7	A M			W	WSW
7	P M			W	SW
8	A M			W	W by SW
8	P M				WSW
9	A N				WSW
9	P M				WSW
10	A M				W
10	P M				

No. 8.—Three feet and four inches high; in pasture field, isolated.

Sept.	Time.	Upper.	2	3	4
3	A M	N	N	N	S
3	P M	N	NW	NNW	S
7	A M	Destr.	Destr.	Destr.	Destr.

No. 9.—Four and one-half feet high; in pasture field, isolated.

Sept.	Time	Upper.	2	3	3^2	3^3	4	4^2	4^3	5	5^2
3	A M	NE by N	SW	S			NE				
3	P M	E	NW	S			NE				
7	A M	NE	NW	SSW	SE	S	ENE	E by SE		SW	
7	P M		NW	SSW	SSE	SW	NE	up E		SW	
8	A M		WNW	SSW	SE	SSW	ENE	E by SE		SW	
8	P M		WNW	SSW	SE	SW	NE	ENE	NNW	SW	
9	A M		NNW	SSW	ESE	SSW	NE	E	up	SW	SSE
9	P M				SE	SW		E	up SW	SW	SE
10	A M				ESE	SSW		ENE	up NNE	SW	ESE
10	P M				E by SE	SW		NE	NW		ESE
11	A M					SW		NE	NNE		E
11	P M					W		NE	N		ESE
12	A M					WSW		NE	ENE		E by SE
13	A M					SW		E by SE	NE		ESE

No. 9—Concluded:

Sept.	Time.	5[3]	6	6[3]	7	7[3]	8	9	10	11	12
3	A M										
3	P M										
7	A M		SE		NW		S by SW	E by SE	SSW	SSE	
7	P M		SE		N NW		SSW	E by SE	SW	SE	
8	A M		SE		N NW		S by SW	E by SE	SSW	SE	
8	P M		SE		NW		SSW	E by SE	WSW	SSE	E
9	A M		SE		NW		SSW	E by SE	SW	SE	E
9	P M		SE by S		NW	up	SW	E by SE	WSW	SSE	E
10	A M	up	SSE	ESE	NW	up SE	SW	E	W by SW	SSE	E
10	P M	up W		NE		up S				SSE	E
11	A M	up NE		E		SE					E
11	P M	up W		E by SE		E by NE					E
12	A M	up		E		ENE					E
13	A M	up WNW		E		SSW					E
13	P M	S									

No. 10.—In pasture field, isolated.

September.	Time.	Upper.	2	3	4	5
3	A M	N by NW				
3	P M	N				
7	A M	Destr.	ESE	ESE		
7	P M		SE	ESE	NNW	
8	A M		SE	ESE	NE	
8	P M		SE	ESE	NNE	
9	A M		SE	ESE	NE	
9	P M			ESE	N by NE	SW
10	A M				NE	S
10	P M				NNE	SW
11	A M				NNE	SW
11	P M				N	S
12	A M				NNE	S by SW
13	A M				NE	S by SW
13	P M					SW
14	A M					SSW
14	P M					SSW
15	A M					SSW
15	P M					SSW
16	A M					SSW
16	P M					SW
17	A M					SW
17	P M					

No. 11.—Four feet eight inches high; in pasture field, isolated.

Sept.	Time.	Upper.	2	3	4[2]	4[3]	5[2]	5[3]	6	7	7[2]
3	A M	NW	SW	E					E by NE	up	
3	P M	NE	SW	E					NE	SW	
7	A M			Destr.	NE	SSW	SE		E by NE	SW	S
7	P M				NE	S by SW	E		E by NE	SW	S
8	A M				NE	N by NW	ESE		E	SW	S by SE
8	P M				NNE	up N	SSW		E by NE	WSW	S by SW
9	A M				NNE	S	SW	E	E	WSW	S
9	P M				NNE	SSW	SSW	SSE	E	WSW	S
10	A M					SSW	SSW	S by SE	E by NE		SSW
10	P M							up S			
11	A M							up S			
11	P M							WSW			
12	A M							SE			
13	P M							SSE			

No. 11—Concluded:

September.	Time.	7[3]	8	10	11	12	18
3	A M						
3	P M						
7	A M		E by SE	S			W by NW
7	P M		ESE	S	E by SE		SE
8	A M		ESE	S	E		S
8	P M		ESE	S by SW	E by NE	NW	S by SW
9	A M		ESE	S by SW	E by NE	NW	S by SE
9	P M		ESE	S by SW	E by NE	NW	S
10	A M	NNW			ESE	WNW	S
10	P M	Destr.			ESE	NW	S by SW
11	A M					NW	
11	P M					NW	
12	A M					WNW	
13	A M					NW	

No. 12.—Twenty-five inches high; in pasture field, isolated.

September.	Time.	Upper.	2	3
3	A M	E by NE		
3	P M	E		
7	A M		E by SE	
7	P M		SE	
8	A M		E	
8	P M		up E	
9	A M		ENE	
9	P M		ENE	W
10	A M			up S
10	P M			SSW
11	A M			SW
11	P M			W by SW
12	A M			W by SW
12	P M			WSW
13	A M			WSW
14	P M			

No. 13.—Thirty-three inches high; poplar trees two-thirds rod east; maple grove two rods south.

September.	Time.	Upper.	2
7	A M	NW	
7	P M	NW	
8	A M	NE	
8	P M	NNE	N
9	A M	NNE	NE by N
9	P M	NNE	N by NE
10	A M	Destr.	Destr.

No. 14.—Twenty-four inches high; poplar tree two-thirds rod east; maple grove two rods south.

September.	Time.	Upper.
7	A M	NW
7	P M	WNW
8	A M	WNW
8	P M	WNW
9	A M	WNW
9	P M	WNW
10	A M	WNW
10	P M	WNW
11	A M	WNW
11	P M	

No. 15.—Thirty-nine inches high; uppermost heads cut off; poplar trees two-thirds rod east maple grove two rods south.

September.	Time.	1	2	3	4	5
7	A M.	E	N by NE	W		
7	P M.	up E	N by NE	W by SW		
8	A M.	E	N by NE	SSW		
8	P M.	N	NW	W by SW		
9	A M.	ENE	NNE	W by SW	E by NE	
9	P M.	E by NE	NNE	W	ENE	SW
10	A M.	Destroyed	Destroyed	Destroyed	N	NNW
10	P M.				E	WNW
11	A M.				E	N by NE
11	P M.				NNE	NW
12	A M.				NE	NW
13	A M.				NE	NW
13	P M.				NE	NW
14	A M.				up	
14	P M.				ENE	
15	A M.				E	
15	P M.				E	

No. 16.—Three and one-half feet high; uppermost heads cut off; poplar trees two-thirds rod east; maple grove two rods south.

Sept.	Time.	2	2^2	3^2	3^3	5	5^2	5^3	6	6^2	6^3
7	A M	SSE		SSW	E	ESE			SW		
7	P M	SE by E		SW by S	SE	SE by E			WSW		
8	A M	ESE		SSW	SE	SE			SW		
8	P M	ESE	N	SSW	ESE	SE	ENE		SW by W		
9	A M	ESE	E	SSW	ESE	SE	E	ESE	SW		
9	P M	ESE	NE	SSW	ESE	SE	E	ESE	SW	SSE	
10	A M		up NW		ESE		up ENE	up E		up NNE	
10	P M		NNW				ENE	SW		SSE	
11	A M		NE				E	ESE		SE	SW
11	P M		N				NE	SSE		SSE	WSW
12	A M		NNE					SE		SE	WSW
13	A M		N by NE							Destr.	Destr.

No. 16—Concluded:

Sept.	Time.	7	7^2	8	10	11	12	13	14
7	A M	E		S by SE	E	S	NNE	E by SE	
7	P M	ENE		S by SE	E	SW	N	E by SE	W by SW
8	A M	E by NE		SSE	E	S by SW	N	SSE	W by SW
8	P M	NE		S	E	SW	N by NW	SE	W
9	A M	ENE		SSE	E by SE	SSW	NNE	SE	SW by W
9	P M	ENE	NW	SSE	E	SW	NNW	SE	W by SW
10	A M		up SW			SW	NNW	SE	WSW
10	P M		up NW			SW	N	SE	W
11	A M		NW			S	NE		SW
11	P M		NW			W	NNW		W
12	A M		up			W	N		W by SW
13	A M		Destr.			W	NNW		WSW

No. 17.—Thirty-four inches high; south of corn-field.

September.	Time.	Upper.	2
7	A M	NE	
7	P M	NE	
8	M A	ENE	
8	P M	NE	
9	A M	NE	ENE
9	P M		ENE
10	A M		NE
10	P M		NNE
11	A M		NNE
11	P M		N by NE
12	A M		N by NE
13	A M		NNE

No. 18.—Thirty-two inches high; south of corn-field.

September.	Time.	Upper.	2
7	A M	up E	
7	P M	ENE	
8	A M	E by SE	
8	P M	NE	
9	A M	E by NE	
9	P M	ENE	
10	A M	ENE	
10	P M	NNE	
11	A M	NE	
11	P M	N	
12	A M	N by NE	
13	A M	SE	

No. 19.—Five feet and eight inches high; east side of corn-field; close to plum thicket; inclined westward; uppermost head mature.

September.	Time.	2	3	3^2	4	4^2	4^3	5	5^2
7	A M	SW	ENE	S by SE	W	W	SSW	SE	S by SE
7	P M	SW	ESE	S	W	WSW	SSW	SE	SE
8	A M		ESE	S	W	W	SSW	SE	SE
8	P M		ESE	S by SW	W	W	SSW	SE	SE
9	A M		ESE	S by SW	W	W	SSW	SE	SE
9	P M			S by SW		W by NW	SSW		SE
10	A M								SE
10	P M								SE
11	A M								
11	P M								
12	A M								
13	A M								
13	P M								

No. 19—Continued:

Sept.	Time.	5^3	6	6^2	7	7^2	8	8^2	9
7	A M		NNW	SW	WSW	SW	SE	S	W by SW
7	P M		NNW	SSW	WSW	SW	SE	S	W by SW
8	A M		NNW	SW	WSW	SSW	SE	S by SE	W by SW
8	P M	SSW	NNW	W	W	SW	SE by E	S by SE	W by SW
9	A M	S	NNW	WNW	W	SSW		SSE	W by SW
9	P M	SW		NW	W	SW		SSE	W
10	A M	up S		up NW		ESE		up ESE	
10	P M	SW				ESE		E by SE	
11	A M	SE				ESE		ENE	
11	P M	NNE				ENE		NNE	
12	A M	NE				NE		NE	
13	A M	SSE				SE		SE	
13	P M	Destr.							

No. 19—Concluded:

September.	Time.	9[2]	10	11	12	13	14	15
7	A M.	SW	SW	NNW	W by SW	SSE	.....	.....
7	P M.	SW	SW	NNW	WSW	SE	up W	SSW
8	A M.	SSW	SW	NW	WSW	SE	WSW	SW
8	P M.	SW	SW	NNW	W	SE	up W	SSW
9	A M.	SW	WSW	NNW	W	SE	WNW	SW
9	P M.	SW	WSW	NW	W	SE	WNW	SW
10	A M.	up SE	.....	.....	.....	SE	WNW	SW
10	P M.	up ESE	.....	.....	.....	.....	.....	.....
11	A M.	E	.....	.....	.....	.....	.....	.....
11	P M.	ENE	.....	.....	.....	.....	.....	.....
12	A M	ENE	.....	.....	.....	.....	.....	.....
13	A M.	.....	.....	.....	.....	.....	.....	.....
18	P M.	.....	.....	.....	.....	.....	.....	.....

No. 20.—Three feet and nine inches high; east of corn-field; close to plum thicket.

September.	Time.	Upper.	2	3
7	A M.	ESE	W	.....
7	P M.	ESE	ESE	.....
8	A M.	ESE	up S	.....
8	P M.	ESE	up NE	E by NE
9	A M.	E	up SE	ESE
9	P M.	.....	up	E
10	A M.	.....	up E	E by SE
10	P M.	.....	up	E by NE
11	A M.	.....	N	NNE
11	P M.	.....	up	ENE
12	A M.	.....	up N	ENE
13	A M.	.....	.....	SSW

No. 21.—Four feet and seven inches high; south of corn-field.

Sept.	Time.	Upper.	2	3	4	5	6	7
7	A M.	SE by E	S	S	S by SE	.....	.....	.....
7	P M.	SSE	S by SW	SW	SE	.....	.....	.....
8	A M.	SE	SE	ESE	SE	S by SE	NE	.....
8	P M.	up	S by SW	W by SW	SE	S by SW	NNE	.....
9	A M.	up	SE by E	E by SW	ENE	S by SW	NNE	.....
9	P M.	.....	SW	ENE	E	S by SW	N by NE	.....
10	A M.	.....	SSE	NE	SE	S by SW	N	.....
10	P M.	.....	S	N	SE	SW	N	.....
11	A M.	.....	S	NE	E	S by SW	NNE	.....
11	P M.	.....	S	N	ENE	SW	N	.....
12	A M.	.....	W by SW	N	E	SW	N	SE
13	A M.	.....	WSW	ENE	SE	S	up	SE
13	P M.	.....	.....	.....	.....	WNW	N	SE
14	A M.	.....	.....	.....	.....	NW	.....	SE
14	P M.	.....	.....	.....	.....	SW	.....	SE
15	A M.	.....	.....	.....	.....	SSW	.....	SE by E
15	P M.	.....	.....	.....	.....	SSW	.....	SE
16	A M.	.....	.....	.....	.....	.....	.....	SE
17	A M.	.....	.....	.....	.....	.....	.....	ESE
17	P M.	.....	.....	.....	.....	.....	.....	E

No. 22.—Three feet and six inches high; south of corn-field.

September.	Time.	2	3	4
7	A M.	up E	SSW	
7	P M.	up ENE	SW	
8	A M.	ENE	S by SW	
8	P M.	ENE	SW	
9	A M.	ENE	up SW	up E
10	A M.			up ENE
10	P M.			E
11	A M.			ENE
11	P M.			E
12	A M.			E
13	P M.			ENE
14	A M.			up ENE
14	P M.			up E by SE
15	A M.			up ENE
15	P M.			ESE
16	A M.			ESE

No. 23.—Six feet and five inches high; south of corn-field.

September.	Time.	4[2]	4[3]	5	5[2]	6	7	7[2]	7[3]
7	A M.	SSE	SW	WSW	S by SW	ESE	SSW	S	
7	P M.	SSE	SW	SW	S	SE	S by SW	S	
8	P M.	SE	SW	WSW	S by SW	ESE	SSW	S by SW	
9	A M.	SE	SW	WSW	up SE	ESE	SSW	S	up SW
9	P M.	SE	SW	WSW	SW		SSW	S by SW	up WSW
10	A M.	SSE	SW		up NNW		SW	S	up SW
10	P M.		SW		N		SW	S by SW	up SW
11	A M.				N		SW	S by SW	SW
11	P M.				N by NE		WSW	SW	W
12	A M.				ENE			SSW	W by SW
13	A M.				E			S	SSW
13	P M.							SSW	W
14	A M.							SSW	up WSW
14	P M.							SSW	up WSW
15	A M.							S by SW	up WSW
15	P M.								W
16	A M.								W
16	P M.								

No. 23—Continued:

Sept.	Time.	8	8[2]	9	9[2]	10	11	11[2]	11[3]
7	A M.	NNE	SE	SSE	SE	W by SW	SE	NE	SW
7	P M.	NNE	SE	SSE	S by SE	W by SW	SE	ENE	SE
8	P M.	NNE	E by SE		S by SW	W	ESE	NNE	ESE
9	A M.	NNE	E by SE		SSE	W	ESE	NNE	ESE
9	P M.		ESE		S by SE			NE	ESE
10	A M.		NE		SSE			E by NE	E by SE
10	P M.		NE		W			N by NE	E
11	A M.		NE		NW			NNE	ENE
11	P M.		NNW		NE			N by NE	ENE
12	A M.							NNE	E by NE
13	A M.							ENE	E by NE
13	P M.								E by NE
14	A M.								E
14	P M.								
15	A M.								
15	P M.								
16	A M.								
16	P M.								

No. 23—Continued:

Sept.	Time.	12	12[2]	13	14	14[2]	15	16	17
7	A M.	SSW	SSE	NW	SE		W by NW	ESE	S by SE
7	P M.	SW	S	NW	SSE		WNW	E	S
8	P M.	SW	S	WNW	ESE		WNW	E by NE	S
9	A M.	SW	S by SE	NNW	ESE	SE	WNW	E by NE	S
9	P M.		S by SW			SE		E by NE	
10	A M.		S by SW			SE			
10	P M.		SW			SE			
11	A M.		SSW			SE			
11	P M		SW			SE			
12	A M.					SE			
13	A M.					ESE			
13	P M.					ESE			
14	A M.					SE by E			
14	P M.					SE			
15	A M.					SE			
15	P M.					SE			
16	A M.					SE			
16	P M.					SE			

No. 23—Concluded:

September.	Time.	17[2]	18	19	20	21	24	25
7	A M.	ESE	WNW	ESE	SSW		E by NE	
7	P M.	E	WNW	ESE	SSW		E by NE	
8	P M.	ESE	WNW	ESE	SW	N	E by NE	S by SE
9	A M.	E by SE	WNW	ESE	SW	N	E by NE	S by SE
9	P M.	E by SE	WNW		WSW	N	E	S
10	A M.	E by SE	NW			up N	ENE	SSW
10	P M.	E by SE				N	ENE	SW
11	A M.	ESE				up N	ENE	SSW
11	P M.	SE by E				NNW	NE	SW
12	A M.	S by SE				N	ENE	SSW
13	A M.	up S				N	E by NE	S
13	P M.	up ESE				N		SSW
14	A M.	up E				N		S by SW
14	P M.					N		S by SW
15	A M.					N		S by SW
15	P M.							
16	A M.							
16	P M.							

No. 24.—Five feet and seven inches high; in corn-field; uppermost head mature.

Sept.	Time.	2	3	4	4[2]	4[3]	5	5[2]	5[3]
7	A M.	SW	SE	SW	SW	SW	SW		
7	P M.	SW	SSE	WSW	SW	SE	SSW		
8	A M.	SW	SSE	W by SW	S by SW	SW	SW		
8	P M.	SW	SSE	W	SW	WSW	SW	up SW	
9	A M.	SW	SE	W	up SW	WSW	SW	up SE	up SE
9	P M.		SE		SSW	WSW	SW	up SW	SE
10	A M.				SSW	WSW		up E	ESE
10	P M.							up NE	SE
11	A M.							NE	ESE
11	P M.							N	E
12	A M.							N	ESE
13	A M.							SSE	SE
13	P M.							N	N
14	A M.							up NE	up
14	P M.							up E	SW
15	A M.							E	SW
5	P M.								SE

No. 24—Continued:

Sept.	Time.	6	6[2]	7	7[2]	8	8[2]	9	9[2]
7	A M.	SE	up W	WSW	.....	S	.....	SSE	.....
7	P M.	SE	up W by NW	WSW	.....	S	.....	ESE	.....
8	A M.	SE	SE	SW	.....	S by SE	.....	E by SE	.....
8	P M.	ESE	NNE	W by SW	.....	S by SW	.....	E by SE	.....
9	A M.	E by SE	ENE	W	up E	S by SE	.....	E by NE	.....
9	P M.	E by SE	ENE	W	SW	S by ESW	.....	ENE	.....
10	A M.	.....	ENE	.....	ESE	.....	ESE	.....	up
10	P M.	.....	.....	.....	E by SE	.....	SE	.....	NNE
11	A M.	.....	.....	.....	SE	.....	ESE	.....	NE
11	P M.	.....	.....	.....	E	.....	S	.....	N
12	A M.	.....	.....	.....	NE	.....	SSE	.....	NNE
13	A M.	.....	.....	.....	SE	.....	S by SE	.....	SE
13	P M.	.....	.....	.....	N	.....	S by SE	.....	NE
14	A M.	.....	.....	.....	up NNE	.....	SSE	.....	NNE
14	P M.	.....	.....	.....	up E by SE	.....	ESE	.....	up
15	A M.	.....	.....	.....	.....	.....	SE	.....	up N
15	P M.	.....	.....	.....	.....	.....	SE	.....	up E
16	A M.	.....	.....	.....	.....	.....	SSE	.....	up

No. 24—Concluded:

Sept.	Time.	10	11	12	13	14	15	17	20
7	A M.	S	S	SSW	.....	N	.....	.....	W by SW
7	P M.	SW by W	ESE	S by SW	.....	S	.....	.....	NE
8	A M.	SW	SE	ESE	.....	SE	up SSW	E by SE	NE
8	P M.	WSW	SE	WSW	.....	.....	NNE	NNE	N
9	A M.	W	SE	E by NE	.....	E by NE	NNE	NE	NE
9	P M.	WNW	SE	E by NE	E	NNW	NE	N	Destr.
10	A M.	WNW	SE	E by NE	E	N by NW	NE	NE	.....
10	P M.	.....	.....	.....	E by SE	.....	ENE	N	.....
11	A M.	.....	.....	.....	E	.....	NNE	NE	.....
11	P M.	.....	.....	.....	E	.....	NE	N	.....
12	A M.	.....	.....	.....	E by NE	.....	S by SE	.....	.....
13	A M.	.....	.....	.....	E by SE	.....	.....	.....	.....
13	P M.	.....	.....	.....	E by SE	.....	.....	.....	.....
14	A M.	.....	.....	.....	E by SE	.....	.....	.....	.....
14	P M.	.....	.....	.....	E by SE	.....	.....	.....	.....
15	A M.	.....	.....	.....	E by SE	.....	.....	.....	.....

No. 25.—Three feet nine inches high; in corn-field.

September.	Time.	Upper.	2	3	4	5	6	7
7	A M.	E	S by SW	E by NE	NNW	.....	.....	.....
7	P M.	ENE	S by SW	ENE	NNW	.....	.....	.....
8	A M.	E by SE	SE	ENE	ENE	ESE	E by NE	.....
8	P M.	E by SE	S	SE	NW	S	NNE	.....
9	A M.	E	SE	E by SE	NE	SE	ENE	.....
9	P M.	.....	SSE	ESE	up N	S by SW	ENE	.....
10	A M.	.....	.....	ESE	NE	ESE	ENE	.....
10	P M.	.....	.....	.....	ENE	ESE	NE	.....
11	A M.	.....	.....	.....	NNE	SE	NNE	.....
11	P M.	.....	.....	.....	N	SE	NE	.....
12	A M.	.....	.....	.....	.....	SE	NE	.....
13	A M.	.....	.....	.....	.....	SSE	ENE	.....
13	P M.	.....	.....	.....	.....	SSE	ENE	.....
14	A M.	.....	.....	.....	.....	ESE	NE	up W
14	P M.	.....	.....	.....	.....	.....	.....	N
15	A M.	.....	.....	.....	.....	.....	.....	N by NE
15	P M.	.....	.....	.....	.....	.....	.....	NW
16	A M.	.....	.....	.....	.....	.....	.....	up WNW
16	P M.	.....	.....	.....	.....	.....	.....	WNW
17	A M.	.....	.....	.....	.....	.....	.....	WNW

No. 26.—Two feet high; poplar trees two-thirds of a rod east; maple grove two rods south.

September.	Time.	Upper.
8	A M	NE
8	P M	NNW
9	A M	N by NE
9	P M	N by NW
10	A M	NNW
10	P M	NW
11	A M	N by NW
11	P M	NW
12	A M	WNW
13	A M	WNW

No. 27.—Sixteen inches high; on north side of and very close (six inches) to a large poplar tree.

September.	Time.	Upper.
8	A M	NE
8	P M	NW
9	A M	N by NW
9	P M	NW
10	A M	NW
10	P M	NW
11	A M	NW

No. 28.—Three feet high; isolated, in pasture field.

September.	Time.	Upper.	2	3	4	5
8	A M	ESE				
8	P M	SE	up SW			
9	A M	E by SE	up SE	E		
9	P M	E by SE	up SW	E by NE		
10	A M	E by SE	up S by SW	E		
10	P M	NE	SW	up NE		
11	A M	E	ESE	NE	up S	
11	P M		SE	NNE	up SW	up SW
12	A M		ESE	NW	SSW	SSW
13	A M		ENE	W	S	
13	P M		Destr.	Destr.		

No. 29.—Three feet and three inches high; isolated, in pasture field.

Sept.	Time.	Upper.	2	3	3²	4	5	6	7	8
8	A M	ESE								
8	P M	SW								
9	A M	ESE	up	ESE						
9	P M	E by SE	W by NW	ESE						
10	A M	E by SE	up E	SE by S		up N				
10	P M	Destr.		SE		up W	ESE			
11	A M			SE		Destr.	WSW			
11	P M			SE						
12	A M			ESE			ESE	SE	up	SE
13	A M			SE			E by SE	E	SW	SE
13	P M						Destr.	ESE	NW	SE
14	A M							E	WNW	SE
14	P M							E	WNW	SE
15	A M				up			ENE	NW	ESE
15	P M				up			E by NE	NW	SE by E
16	A M				up			E by NE	NW	ESE
16	P M				up E by NE			NW		

No. 30.—Thirty-two inches high; isolated, in pasture field.

Sept.	Time.	Upper.	2	3	4	5	6
8	A M	E					
8	P M	NE					
9	A M	ESE					
9	P M	E by SE	SW	SE			
10	P M	E by SE	SSE	SE			
10	A M	NE	WSW	SE			
11	A M	E by NE	SE	E by SE			
11	P M	NE	SW	ESE	NNW		
12	A M	ENE	SSE	ESE	NE		
13	A M	SSE	S	S	NW		
13	P M		WSW	SE	NW		
14	A M		WSW	SE	NNW	WSW	ENE
14	P M		WSW	SE	NNW	WSW	E by NE
15	A M		WSW	ESE	NW	WSW	E
15	P M		SW	ESE	NNW	SW	E
16	A M		SW	SE by E	NW	SW	E by SE
16	P M			SE	NW	WSW	ESE
17	A M			SE	NW	WSW	E by SE
17	P M			SE	NNW	W	E

No. 31.—Eleven feet high; south of corn-field; uppermost four heads mature and therefore not counted.

Sept.	Time.	4[2]	5[3]	6[2]	6[3]	7[2]	7[3]	8[3]	8[4]	8[5]	9[2]
8	A M	S	up	S	SW	WSW	SW	ESE	S	ESE	SE
8	P M	SSE	up WSW	SSE	up SSW	WSW	SW	ESE	S	SE	E
9	A M	SE	up SE	SE	SE	WSW	up SE	ESE	SE	ESE	E
9	P M	SSE	up SW	SE	SW	W	up SW	ESE	SSE	SE	E
10	A M	ESE	up W		SW		up W		SSE	SE	
10	P M	ESE	WNW		WSW		NW		up S	SE	
11	A M						N		S	SE	
11	P M										
12	A M										
13	A M										
13	P M										
14	A M										
14	P M										
15	A M										
15	P M										

No. 31—Continued:

Sept.	Time.	9[3]	10[3]	10[4]	11[4]	11[5]	11[6]	11[7]	12[2]	12[3]	13[3]
8	A M	SE	WSW	S	SE	up S	SE	SE	SSW	up SW	S by SW
8	P M	ENE	W by S W	S	SE	SE	ESE	ESE	S by SW	W	S by SW
9	A M	ENE	W by SW	SE	ESE	SE	ESE	ESE	SE	up NW	S by SW
9	P M	ENE	W	SW	ESE	SE	SE	E by SE	SW	NW	SSW
10	A M	NE		up E	ESE	SE	E	ENE	up SW	NW	SW
10	P M			N			NE	NE	up SW	NNW	
11	A M			NE			NE	NE			
11	P M			NNW			NNW	NNW			
12	A M			N			NE	NNE			
13	A M			S S W			ESE	ESE			
14	A M			NW							
14	P M			W by N W							
15	A M			W							

No. 31—Continued:

Sept.	Time.	13[4]	14[2]	14[3]	15[2]	15[3]	15[4]	16[4]	16[5]	16[6]	17
8	A M	S	SW	NNE	S	SSE	.....	ENE	SSE	SSE	N by NE
8	P M	S by SE	E by NE	NNW	S by SW	S	.....	ENE	SE	SE	N
9	A M	ESE	E by NE	NNE	S	E	.....	ENE	SE	SE	N
9	P M	S	E by NE	N	SW	up SW	.....	ENE	SE	SE	.....
10	A M	up NE	.....	.....	SW	up N	.....	.....	.....	SE	.....
10	P M	NW	.....	.....	.....	N	.....	.....	.....	ESE	.....
11	A M	N	.....	.....	.....	.....	ESE	.....	.....	.....	.....
11	P M	NNW	.....	.....	.....	.....	NE	.....	.....	.....	.....
12	A M	N	.....	.....	.....	.....	SE	.....	.....	.....	.....
13	A M	SSE	.....	.....	.....	.....	SE	.....	.....	.....	.....
13	P M	.....	.....	.....	.....	.....	up N	.....	.....	.....	.....
14	A M	.....	.....	.....	.....	.....	NW	.....	.....	.....	.....
14	P M	.....	.....	.....	.....	.....	SE	.....	.....	.....	.....
15	A M	.....	.....	.....	.....	.....	ESE	.....	.....	.....	.....
15	P M	.....	.....	.....	.....	.....	SE	.....	.....	.....	.....
16	A M	.....	.....	.....	.....	.....	SE	.....	.....	.....	.....
16	P M	.....	.....	.....	.....	.....	S by SE	.....	.....	.....	.....
17	A M	.....	.....	.....	.....	.....	ESE	.....	.....	.....	.....
17	P M	.....	.....	.....	.....	.....	ESE	.....	.....	.....	.....

No. 31—Continued:

Sept.	Time.	18[2]	18[3]	18[4]	19[2]	19[3]	20[2]	20[3]	20[4]	21[3]	21[4]
8	A M	E by NE	SE	SE	.....	SE	ESE	.....	.....	SE	SE by S
8	P M	E by SE	SE	SE	.....	N	S by SE	.....	.....	SE	SE
9	A M	E by SE	SE	ESE	.. ..	ESE	SSE	.....	.....	ESE	ESE
9	P M	.....	.....	ESE	ESE	ESE	SSE	.....	.....	ESE	ESE
10	A M	.....	.....	ENE	up NE	NE	.....	up E	.....	.....	.....
10	P M	.....	.....	NNW	NNE	NNE	.....	N	.....	.....	.....
11	A M	.....	.....	.....	NNE	.....	.....	NE	.....	.....	.....
11	P M	.....	.....	.....	NNW	.....	.....	N	W	.....	.....
12	A M	.....	.....	.....	N	.....	.....	N by NE	W	.....	.....
13	A M	.....	.....	.....	SE	.....	.....	SE	SW	.....	.....
14	A M	.....	.....	.....	.....	.....	.....	up NE	SW	.....	.....
14	P M	.....	.....	.....	N	.....	.....	up NE	SW	.....	.....
15	A M	.....	.....	.....	.....	.....	.....	NE	SW	.....	.....
15	P M	.....	.....	.....	.....	.....	.....	up NE	SW	.....	.....
16	A M	.....	.....	.....	.....	.....	.....	.....	SW	.....	.....
16	P M	.....	.....	.....	.....	.....	.....	.....	W by SW	.....	.....
17	A M	.....	.....	.....	.....	.....	.....	.....	W by SW	.....	.....

No. 31—Concluded:

Sept.	Time.	21[5]	23[2]	23[3]	26[2]	26[3]	26[4]	27	28
8	A M.	E by SE	SSW	up E	ESE	ESE	SE	N by NE	.....
8	P M.	E by SE	S by SW	up	ESE	ESE	SE	N by NE	.....
9	A M.	E	S by SE	up E	ESE	ESE	SE	N by NE	.....
9	P M.	E by NE	S by SW	up NE	ESE	ESE	SE	N	.....
10	A M.	ENE	.....	.....	.....	.....	.....	.....	.....
10	P M.	NE	.....	.....	.....	.....	.....	.....	.....
11	A M.	NE	.....	.....	.....	.....	.....	.....	.....
11	P M.	N	.....	.....	.....	.....	.....	.....	.....
12	A M.	NNE	.....	.....	.....	.....	.....	.....	NE
13	A M.	ESE	.....	.....	.....	.....	.....	.....	ENE
14	A M.	.....	.....	.....	.....	.....	.....	.....	NE
14	P M.	.....	.....	.....	.....	.....	.....	.....	NE
15	A M.	.....	.....	.....	.....	.....	.....	.....	NE
15	P M.	.....	.....	.....	.....	.....	.....	.....	NE
16	A M.	.....	.....	.....	.....	.....	.....	.....	NE

No. 32.—Five feet three inches high; thick grove one-half rod west; south of corn-field.

September.	Time.	Upper.	2	3	3[2]	4	5	6
9	A M.	NE	E by S	E		ENE	E	E by NE
9	P M.	NE	E	E		NE	E	E
10	A M.	NNE	ENE	E		NE		E by NE
10	P M.	NNE	ENE	E by NE		ENE	NE	E by NE
11	A M.							E by NE
11	P M.							NE
12	A M.							E by NE
13	A M.							E
13	P M.				E by SE			
14	A M.				ESE			
14	P M.				SE by E			
15	A M.				SE			
15	P M.				SE			
16	A M.				SE			
16	P M.				ENE			
17	A M.				ENE			
17	P M.				NE			

No. 32—Concluded:

September.	Time.	7	8	9	10	11	12	13
9	A M.	NE	ESE	ENE	E by NE	NE	SE	
9	P M.	NE	E	NE	ENE	NNE	S	
10	A M.	N by NE	E	NNE	ENE	NE	SE	
10	P M.	N by NE	E by NE	NNE	NE	S	NE	
11	A M.	NE	E by NE	NNE		S	NE	
11	P M.	N	ENE	NNE		up N	N	N
12	A M.	N		NE		N by NE	ESE	NNE
13	A M.			E		NE	ESE	ENE
13	P M.							ENE

No. 33.—Three feet eight inches high; south of corn-field; grove one-half rod west.

September.	Time.	Upper.	2	3	4	5
9	A M.	NE	E by SE	E	NE	ESE
9	P M.	NE	ENE	E by SE	NE	SE
10	A M.	NE	ENE	E by SE	NE	ESE
10	P M.		up	E by SE	NE	ESE
11	A M.				ENE	E
11	P M.				N by NE	N by NE
12	A M.				NE	N by NE
13	A M.				NE	E

No. 34.—Thirty-four inches high; south of corn-field; grove one-half rod west.

September.	Time.	Upper.	2
9	A M	SW	
9	P M	ESE	
10	A M	ESE	up E
11	A M		NE
11	P M		N
12	A M		N by NE
13	A M		E by SE
13	P M		ENE
14	A M		ENE
14	P M		E by NE
15	A M		E
15	P M		E by NE
16	A M		E
16	P M		NE
17	A M		NE

No. 35.——Twenty-four inches high; south of corn-field; grove one-half rod west.

September.	Time.	Upper.
9	A M	E
9	P M	ENE
11	A M	NE
11	P M	N
12	A M	NE
13	A M	E
13	P M	

No. 36.—Three feet five inches high; six feet east of peach thicket; west of corn-field.

Sept.	Time.	Upper.	2	3	4	5	6
9	A M	NE	ESE	E	ENE		
9	P M	NNE	ESE	E	NE		
10	A M		ESE		NE	Up E by NE	E
10	P M				NNE	ESE	E
11	A M				NE	ESE	E
11	P M				N	NE	ENE
12	A M				NE	E	E
13	A M				NE	ESE	E
13	P M					E by NE	E by NE
14	A M					E by NE	E by NE
14	P M					E by NE	E
15	A M						E
15	P M						E

No. 37.—Thirty-two and one-half inches high; west of corn-field; six feet east of peach thicket.

September.	Time.	Upper.
9	A M	SE
9	P M	E by NE
10	A M	ESE
10	P M	ESE
11	A M	SE
11	P M	ESE
12	A M	ESE
13	A M	ESE
13	P M	

No. 38.—Three and a half feet high; peach thicket six feet westward.

September.	Time.	Upper.	2	3	4
9	A M	ENE	ESE	E	.....
9	P M	NE	SW	E	.....
10	A M	.....	SE	E by NE	up N
10	P M	.....	SE	E by NE	WNW
11	A M	.....	ESE	E	NNE
11	P M	.....	E	ENE	NNW
12	A M	.....	E	E	N
13	A M	.....	.....	NE	N by NE
14	A M	.....	.....	E	NNE
14	P M	.....	.....	E	NE
15	A M	.....	.....	.....	NE
15	P M	.....	.....	.....	NE
16	A M	.....	.....	.....	NE
16	P M	.....	.....	.....	NNE
17	A M	.....	.....	.....	NNE
17	P M	.....	.....	.....	.....

No. 39.—Five feet high; isolated; inclined southward; heads one to four dead.

September.	Time.	5	6	7	8
9	A M	SE	SE	E by SE	ESE
9	P M	S	SE	up	SE
10	A M	SW	SE	up SW	up N
10	P M	SSW	ESE	up NW	up S
11	A M	.....	.....	NE	NE
11	P M	.....	.....	NNW	SSE
12	A M	.....	.....	N	ESE
13	A M	.....	.....	up	S
13	P M	.....	.....	.....	.....

No. 40.—Four and a half feet high; north of corn-field by wire fence.

Sept.	Time.	Upper.	2	3	4	5	6	7	8	9	10	11
9	A M	E by NE	NE	ESE	E by SE	.....	.....	ENE	NE	ESE	E by SE	.....
9	P M	NNE	N	SE	E by SE	up W	SE	ENE	NE	ESE	ESE	ESE
10	A M	.....	N	SE	NE	up SE	SE	.....	NE	ESE	up S	ESE
10	P M	.....	NNW	ESE	NE	up SW	SE	.....	.....	ESE	up SW	ESE
11	A M	.....	.....	.....	NE	SE	ESE	.....	.....	ESE	up S	ESE
11	P M	.....	.....	.....	.....	up NW	ESE	.....	.....	NE	SW	E
12	A M	.....	.....	.....	.....	NE	E by SE	.....	.....	E	SW	E
13	A M	.....	.....	.....	.....	up SE	ESE	.....	.....	E	SE	E
13	P M	.....	.....	.....	.....	up N	up E	.....	.....	.....	S	.....
14	A M	.....	.....	.....	.....	up ENE	up ESE	.....	.....	.....	up SE	.....
14	P M	.....	.....	.....	.....	up S	SE	.....	.....	.....	SSE	.....
15	A M	.....	.....	.....	.....	SE	ESE	.....	.....	.....	SSE	.....
15	P M	.....	.....	.....	.....	S by SE	SE	.....	.....	.....	S by SE	.....
16	A M	.....	.....	.....	.....	SE	SE	.....	.....	.....	SSE	.....
16	P M	.....	.....	.....	.....	.....	.....	.....	.....	.....	SW	.....
17	A M	.....	.....	.....	.....	.....	.....	.....	.....	.....	E by SE	.....
17	P M	.....	.....	.....	.....	.....	.....	.....	.....	.....	up W	.....

NOTES AS TO DIRECTION OF WIND.

Sept. 2. Wind (not strong) from the southeast.

Sept. 3. Wind light, and as on the preceding day.

Sept. 7. Strong wind (and rain) during the preceding night.

Sept. 8. Very light breeze from the north.

Sept. 9. No wind in the morning; *very* light breeze from the east during the day

Sept. 10. Cloudy, and very *light* breeze from the east in the morning; cloudy and a very light breeze from the south and southeast in the evening.

Sept. 11. Cloudy and foggy, and a moderate wind from the south in the morning; clear, and the wind moderately strong from the south and south-southeast in the evening.

Sept. 12. Cloudy, and a slight breeze from the south in the morning; a very strong wind from the north in the evening, and hence no observation recorded.

Sept. 13. Heavy frost; in the evening wind from south-southeast.

Sept. 14. Slight breeze from the south in the morning, which continued through the day.

Sept. 15. No wind.

Sept. 16. Strong breeze from the east in the morning; no breeze in the evening.

Sept. 17. Gentle breeze from the south.

NOTES ON SORGHUM SMUTS.

BY W. A. KELLERMAN AND W. T. SWINGLE.

Sorghum is now an important fodder and sugar plant of our State, and one that is generally supposed to be comparatively free from the attacks of vegetable parasites. It is therefore a matter of interest to record the fact that two species of smut have been found this year at Manhattan—one not previously noticed here nor hitherto reported as occurring in the United States—(*Ustilago Reiliana.*) It will undoubtedly cause serious loss if it becomes prevalent over the State. It attacks not only sorghum, but Indian corn, and even sugar cane also. The other species (*Ustilago Sorghi*), confined to sorghum, is more abundant and likewise a destructive species. The following brief accounts are given of the two species:

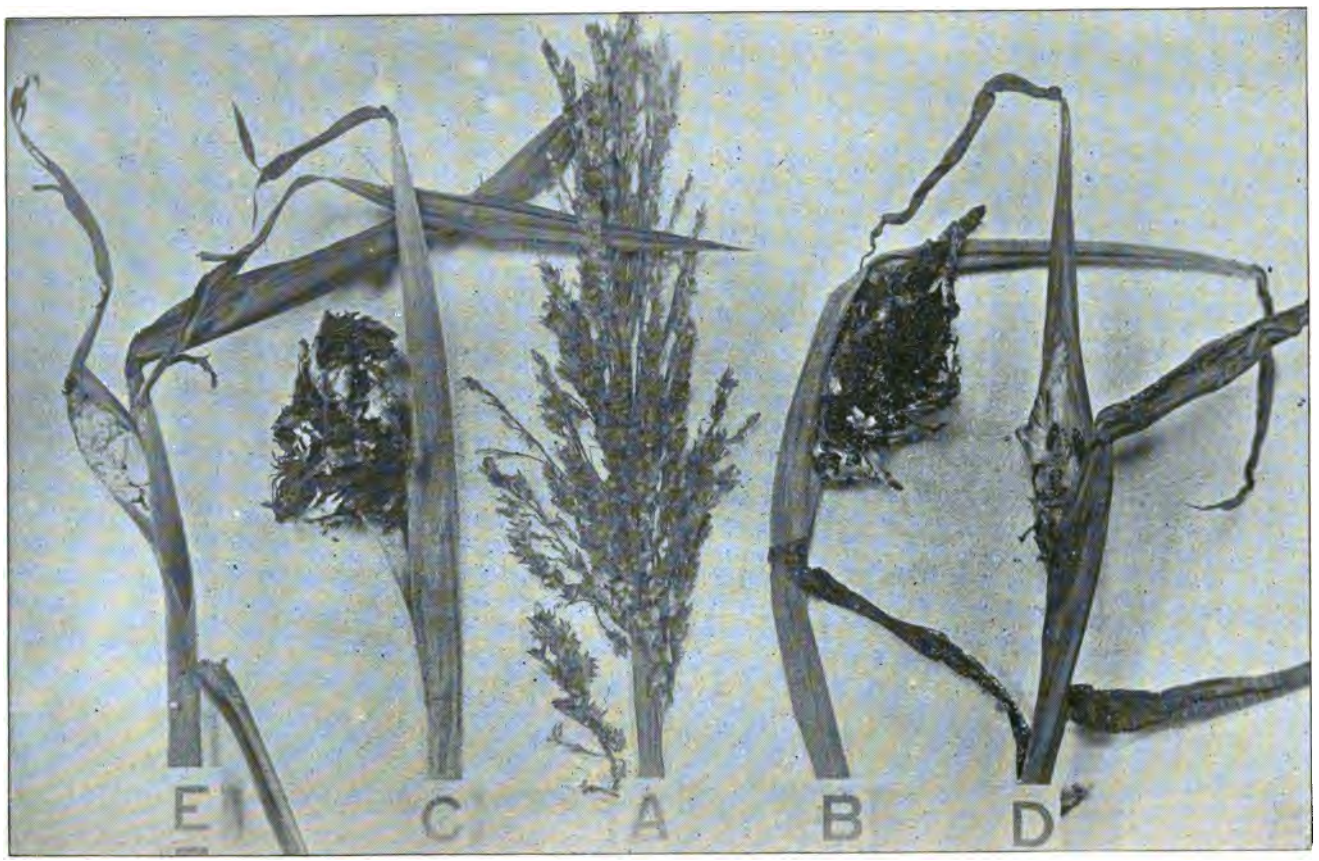
I. USTILAGO SORGHI (Link.?) Passerini, in Thüm. Herb. myc. oec. n. 63. (?*Sporisorium Sorghi* Link. Sp. Pl. II, p. 86.)

This species, which has been reported from Washington, D. C.,[1] Madison, Wis.,[1] New York,[1] and Lincoln, Neb.,[2] on sorghum grown from imported seed, was found by Mr. H. M. Cottrell on the College Farm, Manhattan, Kas., in small quantities, on sorghum raised from seed received from the U. S. Department of Agriculture. The seed had been obtained through the U. S. Consul at Calcutta. It was found later by Prof. G. H. Failyer, on sorghum grown by the Chemical Department on a different part of the College Farm, from seed received from Dr. Peter Collier. The seed in this case had been imported from Africa and not previously grown in this country. One variety grown by the Chemical Department that was attacked, was received under the name of *Huansa Byn*, and the others (designated by numbers) were *Rangoon* varieties. Many of these were badly attacked, and in some cases as many as one-fourth the heads were smutted. The smutted varieties grown by the Farm De partment were very unlike the preceding. Of these there were three numbers quite similar in appearance, and they may have been one and the same variety.

Mr. A. A. Denton, of the Sterling Syrup Works, Sterling, Kansas, has recently sent us a specimen of this smut. He says that in some lots about half of the seed heads were affected. Several varieties of sorghum (vulgare?) were attacked, but all were grown from foreign seed.

This species, unlike the following, attacks only the individual grains, or seeds, in the panicle. They become abnormally large and elongated, and completely filled with the mass of spores.

(1) William Trelease, Preliminary List of the Parasitic Fungi of Wisconsin, p. 34.
(2) H. J. Webber, Rusts and Smuts of Nebraska, Bulletin of the Agr. Exp. Sta. Nebr., No. 11, p. 69; also Catalogue of the Flora of Nebraska in Report of the Botanist, p. 74, Extr. from Report Nebr. State Bd. Agr. for 1889.



SORGHUM SMUT. *(Ustilago Reiliana.)*

II. USTILAGO REILIANA, Kühn, in Rabenhorst, Fungi europæi exsiccati, cent. XX (Dresden, 1875) No. 1988.

This species was found by Mr. J. T. Willard, early in September of this year (1890), in a sorghum plant grown by the Chemical Department. The variety of sorghum (*S. vulgare*) was known as Red Liberian, the seed of which was obtained from the Sterling Syrup Works in 1888. It had been grown at Manhattan continuously since that time, but no smutted heads had, in the meantime, been observed. Only one stalk in the plat was found smutted this year. The uppermost panicle was not smutted, but it produced no seed. The uppermost lateral heads ripened their smut early in September. Other lateral branches were produced until killed by frost. There were in all seven smutted heads produced; four of these, together with the non-smutted panicle, are reproduced in the plate. It can be seen that each of the smutted heads there shown is formed of several lobes, or parts, more or less distinct from each other. In case of each of the last two lateral heads produced (not shown in the plate) there was but one continuous mass of spores, inclosed by a smooth, white membrane. This species has not hitherto been reported in the United States, though it occurs in Egypt on *Sorghum vulgare*, and in Europe on *Sorghum vulgare* and *S. saccharatum* (on the latter by artificial inoculation) and on the male inflorescence (tassel) of maize.

Mr. A. A. Denton reports it at Sterling, Kansas, as the following letter shows:

STERLING, KANSAS, November 16, 1890.

Prof. W. A. Kellerman, Manhattan, Kansas—DEAR SIR: I have to-day hunted over the experimental field for smutted cane-tops, without success. The canes were all cut some time ago, and most have been hauled away, but few remaining in shock upon the land.

I had noticed the two kinds of smut during the season. The five smutted heads, as shown in the larger photograph* which you sent, I had repeatedly noticed. It is not usual, except in one variety, for a cane to have five seed-tops; and the fact that all the heads on one cane were smutted made the case more noticeable.

The other case, in which the grain only was attacked, I had also noticed. In two or three lots many of the seed-heads were thus affected; the berry or the kernel had an unnatural appearance—a whitish color—though the interior of each grain was powdery smut.

Both kinds were, so far as observed, found only in seeds of foreign growth.

I believe that the black powdery seed-heads in which the entire seed-head is a mass of smut similar to the smut found on corn, is occasionally found, or something similar, each year in cane. It was, however, singular that when rank growth was prevented by drouth, five seed-heads on one cane and all of them smutted, should have been noticed only in foreign canes. . . . .

Respectfully, A. A. DENTON.

An account of both of the species here recorded is given by Prof. J. Kühn, Die Brandformen der Sorghum-Arten in Mittheilungen das Vereins für Erdkunde 1877, reviewed in Botanischer Jahresbericht V. Jahrg. (1877) S. 117, Prof. O. Brefeld gives a description of the germination of the spores of *Ustilago Reiliana* in Die Brandpilze, I., S. 94–5 Taf. XI, Figs. 3–7.

EXPLANATION OF PLATE.

Sorghum Smut, Ustilago Reiliana, Kühn, on one stalk of Red Liberian Sorghum. Reproduced from a photograph; figures one-half natural size.

A. Uppermost panicle of plant, not smutted.
B. Second lateral panicle from above, smutted.
C. Third panicle from above, smutted.
D. Fourth panicle from above, smutted.
E. Fifth panicle from above, smutted.

* Reproduced in the accompanying plate.

EQUATION OF THE MEAN MONTHLY 21-YEAR TEMPERATURE CURVE OF LAWRENCE, KANSAS.

BY E. C. MURPHY, LAWRENCE.

Those who have examined Part I, Vol. 12, of the transactions of the Kansas Academy of Science, have seen on the last page a curve called, "Curve of Mean Daily Temperatures for Twenty-one Years."

In order to show clearly the meaning of the equation that I have found, I will explain briefly how this curve is gotten.

Temperature observations have been taken at Lawrence by Professor F. H. Snow three times each day for twenty-one years. The mean of the three temperatures for any one day gives the daily mean temperature for that day. The sum of the daily mean temperatures of any day for twenty-one years divided by twenty-one, gives the daily mean temperature for that day for the twenty-one years. These temperatures are platted to some scale, using time as an absissa and temperature as an ordinate, giving a series of points; these points are connected by a smooth curve. This curve is called curve of *daily* mean temperatures.

If now we add these daily mean temperatures for any month and divide by the number of days in the month, we get the mean monthly temperature of this month for twenty-one years. If these temperatures be platted as above, and the points connected by straight lines, we get chords of the curve whose equation I have found. It is an equation, or relation between mean monthly temperature and time, which has the twelve mean monthly values of temperature for values of time reckoned from the middle of January to the middle of each succeeding month.

Temperature is a periodic function of time, the period being one year. We have twelve values of this function, and the corresponding values of the time to find the form of the function, or the equation of the curve.

If T = temperature, and t = time, we have

T = $\phi(t)$; or if θ is any angle which varies from 0 to 360°, as t varies from 0 to 365 days, we have

$$T = f(\theta) \qquad \qquad (1)$$

The general form of a periodic function is

$$\left.\begin{aligned} f(\theta) = A + a_1 \cos.\ \theta + a_2 \cos.\ 2\ \theta + \\ + b_1 \sin.\ \theta + b_2 \sin.\ 2\ \theta + \end{aligned}\right\} \qquad (2)$$

in which A, a_1, a_2, b_1, b_2, etc., are constants.

In this case, since there are only twelve observed temperatures, equation (2) reduces to

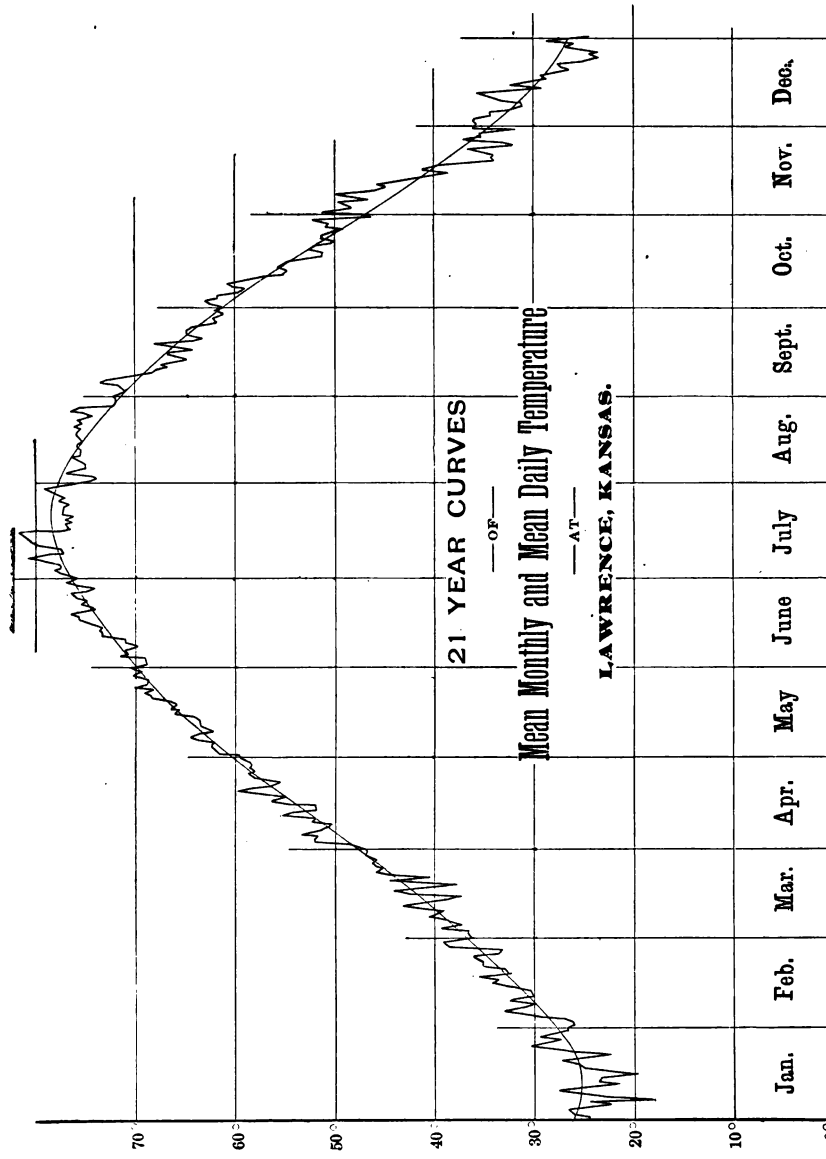
$$\left.\begin{aligned} f(\theta) = A + a_1 \cos.\ \theta + a_2 \cos.\ 2\ \theta + a_3 \cos.\ 3\ \theta + a_4 \cos.\ 4\ \theta + a_5 \cos.\ 5\ \theta \\ + b_1 \sin.\ \theta + b_2 \sin.\ 2\ \theta + b_3 \sin.\ 3\ \theta + b_4 \sin.\ 4\ \theta + b_5 \sin.\ 5\ \theta \end{aligned}\right\} (3)$$

In (3) there are eleven terms and eleven constants.

The twelve observed temperatures, or values of $f(\theta)$, give twelve equations, from which the values of the eleven constants are to be found.

These twelve equations, called observation equations, are

$$\left.\begin{aligned} T_1 = A + a_1 \cos.\ (0) + a_2 \cos.\ 2\ (0) + \ldots + a_5 \cos.\ 5\ (0) \\ + b_1 \sin.\ (0) + b_2 \sin.\ 2\ (0) + \ldots + b_5 \sin.\ 5\ (0) \\ T_2 = A + a_1 \cos.\ 30^\circ + a_2 \cos.\ 2\ (30^\circ) + \ldots + a_5 \cos.\ 5\ (30^\circ) \\ + b_1 \sin.\ 30^\circ + b_2 \sin.\ 2\ (30^\circ) + \ldots + b_5 \sin.\ 5\ (30^\circ) \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ T_{12} = A + a_1 \cos.\ (330^\circ) + a_2 \cos.\ 2\ (330^\circ) + \ldots + a_5 \cos.\ 5\ (330^\circ) \\ + b_1 \sin.\ (330^\circ) + b_2 \sin.\ 2\ (330^\circ) + \ldots + b_5 \sin.\ 5\ (330^\circ) \end{aligned}\right\} \qquad (4)$$


21 YEAR CURVES
—OF—
Mean Monthly and Mean Daily Temperature
—AT—
LAWRENCE, KANSAS.
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
70°
60°
50°
40°
30°
20°
10°
0°

If we substitute $A = \frac{\Sigma T}{n} + B$, $T_1 - \frac{\Sigma T}{n} = l_1$, $T_2 - \frac{\Sigma T}{n} = l_2$, etc., in (4), they reduce to the more convenient form:

$$\left.\begin{array}{l} \left.\begin{array}{l} B + a_1 \cos. (0) + a_2 \cos. 2\,(0) + \ldots + a_5 \cos. 5\,(0) \\ \quad + b_1 \sin. (0) + b_2 \sin. 2\,(0) + \ldots + b_5 \sin. 5\,(0) \end{array}\right\} + l_1 = v_1 \\ \left.\begin{array}{l} B + a_1 \cos. (30^\circ) + a_2 \cos. 2\,(30^\circ) + \ldots + a_5 \cos. 5\,(30^\circ) \\ \quad + b_1 \sin. (30^\circ) + b_2 \sin. 2\,(30^\circ) + \ldots + b_5 \sin. 5\,(30^\circ) \end{array}\right\} + l_2 = v_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \left.\begin{array}{l} B + a_1 \cos. (330^\circ) + a_2 \cos. 2\,(330^\circ) + \ldots + a_5 \cos. 5\,(330^\circ) \\ \quad + b_1 \sin. (330^\circ) + b_2 \sin. 2\,(330^\circ) + \ldots + b_5 \sin. 5\,(330^\circ) \end{array}\right\} + l_{12} = v_{12} \end{array}\right\} \ldots (5)$$

There being twelve observation equations, and only eleven constants to be determined, we can find their most probable values. The most probable values of the constants are those which make Σv^2 a minimum, v being any residual error.

The eleven normal equations, from which the values of the eleven constants are found, are gotten by placing the first differential coëfficient of Σv^2 equal to zero.

These normal equations, after simplification, are as follows:

$$\left.\begin{array}{l} 12B = \Sigma l \\ 6a_1 = l_1 - l_7 + (l_3 - l_9 - l_5 + l_{11}) \sin. 30^\circ + (l_2 - l_8 - l_6 + l_{12}) \cos. 30^\circ \\ 6b_1 = l_4 - l_{10} + (l_3 - l_9 + l_5 - l_{11}) \cos. 30^\circ + (l_2 - l_8 + l_6 - l_{12}) \sin. 30^\circ \\ 6a_2 = l_1 + l_7 - l_{10} - l_4 + (l_2 + l_8 + l_6 + l_{12} - l_3 - l_9 - l_5 - l_{11}) \sin. 30^\circ \\ 6b_2 = (l_2 + l_8 - l_6 - l_{12} + l_3 - l_9 - l_5 - l_{11}) \cos. 30^\circ \\ 6a_3 = l_1 + l_5 + l_9 - (l_3 + l_7 + l_{11}) \\ 6b_3 = l_2 + l_6 + l_{10} - (l_4 + l_8 + l_{12}) \\ 6a_4 = l_1 + l_7 + l_4 + l_{10} - (l_2 + l_8 + l_3 + l_9 + l_5 + l_{11} + l_6 + l_{12}) \sin. 30^\circ \\ 6b_4 = (l_2 - l_3 + l_5 - l_6 + l_8 - l_9 + l_{11} - l_{12}) \cos. 30^\circ \\ 6a_5 = l_1 - l_7 + (-l_2 + l_8 + l_6 - l_{12}) \cos. 30^\circ + (l_3 - l_9 - l_6 + l_{11}) \sin. 30^\circ \\ 6b_5 = l_4 - l_{10} + (l_{11} - l_3 + l_9 - l_5) \cos. 30^\circ + (l_2 + l_6 - l_8 - l_{12}) \sin. 30^\circ \end{array}\right\} \ldots (6)$$

The following table gives the mean monthly temperatures or values of T (computed from Prof. Snow's meteorological record), and the values of $T - \frac{\Sigma T}{n} = l$:

	T.	l.		T.	l.		T.	l.
January	24.86°	−28.08	May............	65.31°	+12.38	September...	66.38°	+13.45
February	32.05	−20.88	June...........	73.62	+20.69	October	54.43	+1.50
March..........	41.47	−11.46	July	78.07	+25.14	November...	39.86	−13.07
April............	54.18	+1.25	August.......	75.44	+22.51	December...	29.46	−23.47

Substituting the value of l_1, l_2, l_3, etc., in equations (6), and solving, we have $A = 52.93^\circ$, $a_1 = -25.70$, $a_2 = -1.12$, $a_3 = -0.47$, $a_4 = -0.05$, $a_5 = -0.43$, $b_1 = +0.10$, $b_2 = 1.02$, $b_3 = 0.17$, $b_4 = 0.25$, and $b_5 = -0.06$.

Substituting these values in equation (3) we have

$$\left.\begin{array}{l} T = f(\theta) = 52.93 - 25.70 \cos. \theta - 1.15 \cos. 2\theta - 0.47 \cos. 3\theta - 0.05 \cos. 4\theta - 0.43 \\ \qquad \cos. 5\theta \\ \qquad + 0.10 \sin. \theta + 1.02 \sin. 2\theta + 0.17 \sin. 3\theta + 0.25 \sin. 4\theta + 0.01 \\ \qquad \sin. 5\theta \end{array}\right\}.$$

NOTE.—In the simplification of the normal equations we use the following results, easily proven true:

$\Sigma \cos. m\theta = 0$, $\Sigma \sin. m\theta = 0$, $\Sigma \sin. m\theta \cos. m\theta = 0$, $\Sigma \cos.^2 m\theta = \frac{n}{2}$, and $\Sigma \sin.^2 m\theta = \frac{n}{2}$, m taking all values from 0 to $n-1$ and $\theta = \frac{360}{n}$, n being any integer.

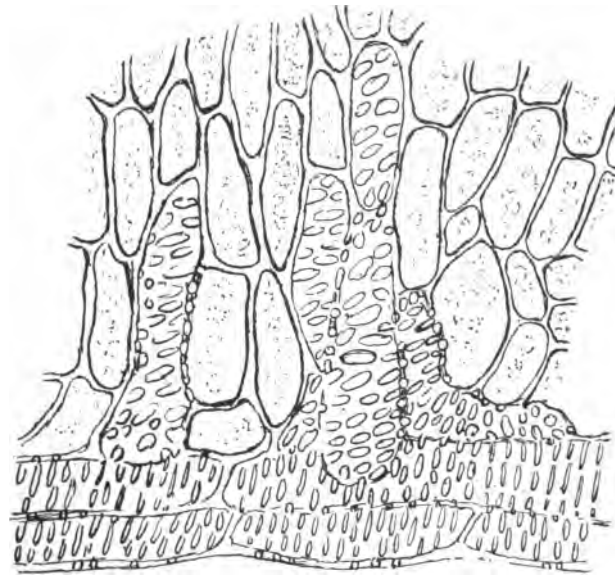
THE UNION OF CUSCUTA GLOMERATA WITH ITS HOST.

W. C. STEVENS, LAWRENCE.

In Hanstein's botanische Abhandlungen, vol. II., 1875, Koch figures one species of Cuscuta, probably C. epilinum, as connected with its host by means of a rootlet which is prolonged into numerous well-defined hairs. By means of these hairs the needed food is absorbed from the host.

The parasitic roots, or haustoria of Cuscuta glomerata, somewhat common with us on Solidago and other compositæ, present some striking differences. A longitudinal section through the slender stem of this species reveals no bundles of bast or wood, nor the variously marked ducts so common in most plants. In their place are tracheids fitfully distributed. The remainder of the stem is evidently parenchymous tissue.

The parasite twines closely about its host and sends off haustoria at short inter-



Longitudinal section showing the fusion of the tracheids of Cuscuta glomerata with the ducts of Solidago.

vals. The haustoria are formed by the rapid division of the parenchymous cells probably at those points where the irritation from pressure is greatest. The tracheids are formed early in the growing tissue. The haustorium bursts through its epidermis, and if in a favorable place, enters its host. Sometimes it is unable to do this, and spreads out as an external disk. If successful in entering the host, it spreads out through the cortical parenchyma, passes between the bast bundles, and to and through the bundles of wood and ducts. Often the tracheids of the haustorium are turned aside when they reach the ducts, becoming closely applied to them for some distance, and apparently fusing with them. The parenchyma of the haustorium becomes lost in the parenchyma of the cortex, so that it would be difficult to tell how far the haustorium extended, but for the tracheids which appear here and there.

As the haustorium grows, its tissues multiply faster than they can distribute themselves through the host, and a disk is formed on the outside.

When the parasite blossoms, that portion of the stem not bearing flowers dies away, and only dense spiral masses of white flowers, closely clinging to the host, are to be seen. On stripping off the inflorescence, it is found that in many instances the haustoria have failed to enter the host, so that the inflorescence, for the distance of an inch or so, is obliged to receive its food-supply through a very slender connection with its host; the ratio of the size of the inflorescence to that of the connective being much greater than in most other plants; still the vigor of the blossoming and the abundance of the starch grains in the numerous bracts of the inflorescence attest that the parasite has been unstintingly fed.

It has been stated that that portion of the parasite not bearing flowers dies away. The remaining portion of the plant loses nothing of stability by this, for as the flowers develop and become more crowded, the spiral is made to bind more closely to the host, and the disks which are found at the base of the haustoria, just outside the host, give extreme rigidity to the union.

NOTE ON THE PRECISION OF THE SOLAR ATTACHMENT TO THE ENGINEER'S TRANSIT.

BY F. O. MARVIN, STATE UNIVERSITY.

It has often been claimed that the solar compass or solar attachment would give no better results than a needle compass, when the declination was well determined and when no unknown local attraction existed.

I have endeavored to determine the degree of average accuracy attainable with the Gurley attachment connected with a Gurley transit. In the instrument used, the limb is read to 20 seconds of arc, the vertical circle and the declination arc, to 30 seconds.

On October 30th, 31st, and November 1st, by observations on Polaris, made with a Fauth secondary triangulation transit, a meridian line was laid on the ground, and checked by a line fixed by the star at its eastern elongation, taking observations in the latter case with the telescope both direct and reversed.

In the course of three days following some sixty-five observations were made with the solar instrument, the angle between each solar meridian and the stellar meridian being measured. Following the usual law of error, the small errors were numerous. The largest angle read was $3' 20''$, while the minimum was represented by three readings of zero error. The average error of pointing for the sixty-five observations was $58''$, with a "probable error for a single observation" of $32''$. I am confident that this degree of precision can be reached, as I have had no extended practice in handling the instrument, and used no more care in the series of observations than should be used in the field.

I found that the range of error seemed to be greater during the morning than during the afternoon. Also that the morning observations generally gave a solar meridian to the west of the stellar meridian, with the reverse effect from the observations in the afternoon. Of 31 morning pointings, 23 were to the west of the stellar line. Of 34 afternoon pointings, 28 were to the east of the stellar line. The instrument used was in good adjustment. The allowance for refraction was that given in Gurley's manual. Whether the instrument on a continued series of observations would show this same peculiarity, I cannot say. If in the present case, however, the allowance made for refraction was too much, the marked tendency in the pointing would be accounted for.

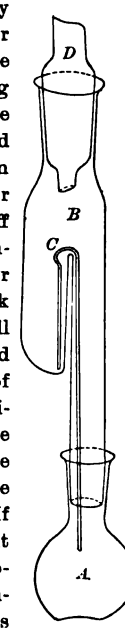
A NEW GLASS SIPHONING EXTRACTION APPARATUS.

J. T. WILLARD AND G. H. FAILYER.

At the meeting of the Academy in 1885 we had the pleasure of describing what still seems to us the simplest percolating extraction apparatus constructed wholly of glass.* We now describe a *siphoning* apparatus which it would seem can hardly be simpler, and which after nearly a year's use we can pronounce entirely satisfactory in its operation.

It may not be out of place to say a few words in justification of the invention of another extractor, notwithstanding the many forms already proposed. In the first place, we are led to reject any extractor which makes cork connections. The extreme difficulty of completely freeing cork from its resinous constituents can only be appreciated by one who has tried it faithfully for a hundred hours or more, placing the properly perforated corks in a large Soxblet extractor and changing the flask occasionally and constantly finding an appreciable extract. The writers have also observed an old, well-used cork suddenly exude a considerable quantity of resin on the upper end of the cork during an extraction. The more perfectly a cork is freed from its resin the less fitted, mechanically, does it become, losing its elasticity and becoming brittle. In the second place, a *siphoning* apparatus must be preferable to a percolating, because we are certain that every particle of the substance is soaked by fresh solvent every time the container is filled, while in a percolating apparatus we can never be quite sure that the solvent is not chiefly flowing down channels of least resistance.

The Soxblet extractor is sometimes made wholly of glass, and in that form will doubtless do good work. Ours, however, has the advantage of greater simplicity, and consequently costs less, as well as being less liable to fracture. By reference to the cut it will be seen that the extractor consists of four parts, viz.: the *flask*, the containing tube, the condensing tube, and the siphon. The flask is small, holding only about 100 cc., and weighing about 20 grams. The containing tube is ground into the neck of the flask, and has a pocket on one side, in which the substance, wrapped in filter paper, is placed for extraction, and into which the short arm of the siphon dips. The condenser tube expands into a stopper for the containing tube, and at the lower end is drawn out and ground off in such a way as to direct the condensed solvent into the pocket containing the substance for analysis. The upper part of the condenser tube passes through a cold-water jacket of some kind; in ours a tank large enough for half a dozen extractors. The siphon is made of small tubing. The internal diameter must not be over one millimeter, and at the bend it is better to have it even less. The capillary attraction of the inner wall of the tube raises the liquid sufficiently to bring the siphon into action before the pocket is full enough to run over. The upper end of the short limb must be bent sharply away from the side of the pocket so as to cut off the capillary action between the outside of the siphon and the side of the pocket against which it touches. If this is not done, the liquid will be drawn over continuously without emptying the pocket, and all the advantages of a siphoning apparatus will be lost. If, however, these details be met in the construction of the siphon, it will act perfectly, and the apparatus will need no attention after the flame under the water bath is adjusted. The ap-



*Transactions Kansas Academy of Science, Vol. X, p. 20; Am. Chem. Journal, Vol. 8, p. 73.

paratus is so constructed that the siphon may be easily removed, and when the extraction is concluded the removal of the siphon and the substance will usually give abundant space to collect the solvent. It is then distilled off from the extract and collected in the pocket. The drying of the extract must be completed in a current of hydrogen, as usual.

This extractor was designed for the quantitative analysis of feeding-stuffs; the side-pocket to contain the substance is therefore made small in our instruments so as to require but little of the absolute ether and to insure quick siphoning. It is, however, apparent that within certain limits the extractor might be made of considerable size.

Our extractors are heated by one water bath; each flask is supported by a spiral spring which has a piece of brass gauze soldered across the upper coil. The spring should be rather stiff, but so adjusted in length as to require but little compression to bring it under the flask.

NOTE.—Mr. J. T. Crawley, in the Am. Chem. Journal, Vol. XI, p. 507, has described an apparatus employing capillary attraction to bring the siphon into action. It is only fair to say that our extractor was designed before the publication of his article.

ANNUAL PRECIPITATION OF RAIN AND SNOW AT MANHATTAN, KANSAS, FOR THE PAST THIRTY-TWO YEARS.

BY C. M. BREESE, MANHATTAN.

The rainfall is often of a local character, so that the measured amount at any one place may hold good for but a limited area. The rainfall at Manhattan, as shown by the accompanying chart, is not claimed to be more than an indication of the precipitation over the rest of the State.

In any agricultural country where the system of irrigation is not practiced, the question of the rainfall and its distribution is one of vital interest—especially that of the distribution. To illustrate: In 1886, 1887 and 1888, the rainfall was about the average, but the crops were poor, being affected by drouth at important periods of growth, and by chinch-bugs. The rainfall of 1889 was a trifle less than that of 1888, and only one inch more than that of 1887, but the crops were excellent. The difference in the distribution of the moisture tells the tale. Again, in 1875 there was a very scanty rainfall, but it was exceedingly well distributed, and I find Riley county is accredited with a wheat crop averaging 14 bushels per acre, corn 41 bushels, oats 28 bushels, and potatoes 90 bushels—pretty good crops for a year when the total precipitation was only 18.16 inches.

"Is the rainfall of Kansas increasing?" Let us examine the record: In the thirty-two years covered there are fourteen above the average, and eighteen below. Dividing the record into two equal periods of time, we find there are in the first half six years above the average, and ten below, while in the second half there are eight above and eight below. The total precipitation for the first half, or previous to 1874, was 468.15 inches, or an annual average of 29.26 inches, while subsequent to and including 1874 there was a precipitation of 508.02 inches, or an average of 31.75 inches, and a difference in favor of the latter period of 2.5 inches per annum. But let us suppose that, instead of extending over thirty-two years, our record had commenced in 1870, and included but twenty years, and we now divide into two equal parts: The total precipitation for the first half is 311.45 inches; for the second, 309.27

inches: *which makes a difference in favor of the first half of .218 inch per annum.* Suppose we divide the period into quarters—

	Total rainfall.	*Yearly average.*
First quarter	245.16	30.645
Second quarter	222.99	27.874
Third quarter	257.08	32.12
Fourth quarter	250.94	31.36

This shows an excess in the third quarter, and a deficiency in the second—surely nothing like what we would expect if we are getting a regular increase in our rainfall. "Is the rainfall increasing?" I hope so, truly, but am free to say I don't know. I don't believe the record proves either that or the converse.

As regards the popular idea that we have a rainfall cycle of seven years, this record does not show that either. It will be noticed that the period from the beginning of the record up to 1866 was very irregular, was one of ups and downs, alternate years being on opposite sides of the average line. Then comes a cycle of seven years, from 1865 to 1872; then another of four years: then one of seven years again, and then one of uncertain duration not finished yet, and which, including 1890, is eight years old and still on the downward trend. The record shows a variation that I think proves nothing, excepting that there is no periodic law that can be depended on in the rainfall at Manhattan.

The greatest rainfall for any one month was for July, 1878, being 12.71 inches.

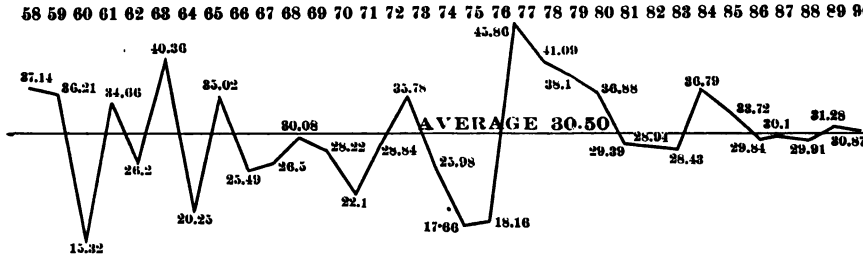
The monthly means, in inches, are as follows:

January	.75	May	3.93	September	3.19
February	.98	June	4.39	October*	2.23
March	1.16	July	4.65	November	1.47
April	2.75	August	3.86	December	.87

This table shows a gradual and steady increase from January, the month of least precipitation, to July, that of the greatest, and from then a steady decrease.

The diagram below exhibits clearly the variation in the rainfall at Manhattan.

RAINFALL AT MANHATTAN, KANSAS, 1858–90.



WIND VELOCITY AT MANHATTAN, KANSAS.

BY C. M. BREESE.

The record of the wind velocity at Manhattan only extends back to February, 1889.

The upper curve shown in the diagram shows the mean velocity of the wind for each hour of the day during the first nineteen months of the record. The figures 1,

*These means include the first ten months of 1890, and consequently their sum does not exactly agree with the average of the chart.

2, 3, 4, etc., denote the hours of the day, beginning at 1 A. M. The points of the curve are at the half-hours; thus the first point marked by figures is at half an hour after midnight, or at 12:30 A. M.; the next at one hour afterward.

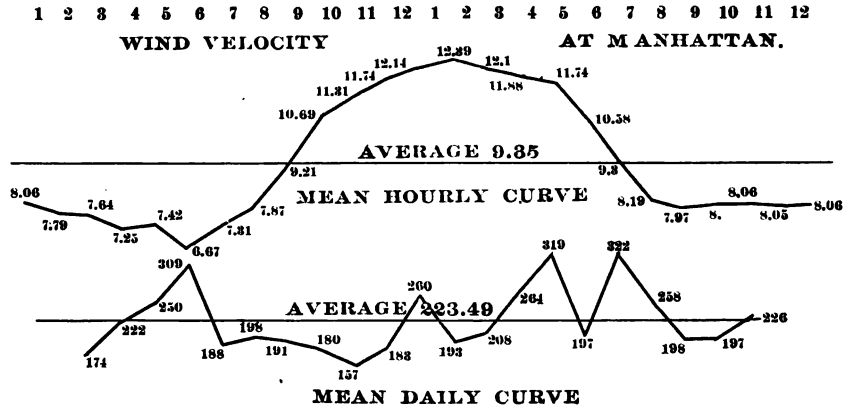
The lowest velocity occurs at about half-past five in the morning, and is 6.67 miles per hour at this time. There is a gradual increase until half-past one in the afternoon, when the maximum—12.39 miles per hour—is reached. From this time until half past seven in the evening a gradual decrease occurs, from which time until about half-past seven in the morning the wind is almost constant. The average hourly velocity at different stations is as follows. The rates for all places excepting Manhattan and Lawrence, Kansas, are taken from Loomis's Meteorology.

Manhattan	9.35	New Orleans	8.00	London, Eng	10.00
Lawrence	15.30	San Francisco	9.00	Madras, India	7.00
New York	11.00	Liverpool, Eng	13.00	Cape of Good Hope	17.00
Chicago	8.00				

The highest velocity that has been recorded was at 6:30 P. M., April 8, 1890, and was sixty miles per hour. It blew at this rate for about ten minutes. The highest record for a whole hour is fifty miles, on the same evening.

The lower curve shows the mean daily velocity for the different months. Beginning with February, 1889, the velocity is shown for each consecutive month up to November, 1890. The figures do not show the exact velocities, but are the nearest whole number. The total number of miles of wind that passed during any month may be found by multiplying the mean daily velocity of that month by the number of days in the month. The lowest velocity was in October, 1889, being 157 miles; the highest in June, 1890, being 322 miles. The highest daily velocity that has been recorded for a single day was 710 miles, on April 11, 1890. The average daily velocity is 223.49 miles, which gives an average hourly velocity of 9.31 miles. This very nearly agrees with the average of the upper curve, the discrepancy being accounted for by the fact that the lower record covers a longer time than the other.

The accompanying diagram presents in condensed form the results of some thousands of calculations.



EVOLUTION IN LEAVES.

BY MRS. W. A. KELLERMAN, MANHATTAN.

Even the most casual observer could not fail to notice the general variation in the foliage of plants; that the various herbs, shrubs and trees bear leaves stamped with an individuality of their own. Anyone would be able to distinguish between

the leaves of the rose and those of the oak. But besides the difference existing between orders, genera and species, there is also often a marked variation in the leaves of one and the same plant; and it is this particular phase of variation to which I wish to call attention.

One of the most familiar plants which furnishes an illustration of this variation among its individual leaves is rubus villosus, common high blackberry, which usually has from three to five leaflets arising from a common point on the footstalk. But many of the leaves do not answer to this description. As will be seen by referring to figures 1–11, the two lower leaflets are often found to be more or less lobed in the trifoliate leaves. Upon closer examination, such a prodigious number of leaves exhibited this peculiarity that I was led to consider them as representing *transition stages* between three and five leaflets. The highest type of the present seems to be five leaflets, and the threes appear to be struggling to reach that number. To make sure that the leaves first observed were not "freaks of nature," or from a botanical standpoint, monstrosities, the whole neighboring region was explored, and everywhere the blackberry leaves exhibited indications of this peculiarity, which I have chosen to designate as an *evolutionary tendency*. The first indication of the division or transition of a leaf, according to my observations, is an enlargement on the portion of the leaf where the division is about to take place; further on in the series, this enlargement becomes a conspicuous bulge, as shown in figure 6, and the vein which is to form the midrib of the newly-formed leaflet becomes strong and prominent; a notch is next formed, which deepens into a lobe, and finally the entire leaflet is given off, as shown in figures 7, 8 and 9. For instance, in the trifoliate leaves of the blackberry, the enlargement will be found on the lower part of the two lateral leaflets, then the various stages of division, resulting finally in the five leaflets. Single leaves were also found in process of division into three leaflets, and two specimens were found bearing six leaflets; one in which the terminal leaflet had thrown off an additional leaflet, and the other with the extra leaflet given off from one of the lowest lateral leaflets. (Figs. 10–11.) My attention being aroused in this direction, I now noticed in very many plants similar transition stages. The ampelopsis quinquefolia, Virginia creeper, afforded numerous illustrations. The normal number of leaflets, as the name indicates, is five, but the transition from five to six and seven leaflets was noted in very many cases; first, an enlargement was observed on the lower or outer portion of the lower leaflets, then a notch, which set forth. One should be able to find transition stages in the cinquefoil; *i. e.*, cases where the division into five leaflets was still in process.

Carlyle says, "How few people think; aye, reader, how few people think"; and we may add, how much there is which we fail to see. How many times before I had examined and admired the leaves of this potentilla, and yet had never appreciated the embryonic history of evolution stamped upon it, for it still retains the single leaflet, perhaps the ancestral type, and transition forms from one to five leaflets are readily found. All pinnate leaves which were observed, except those of the rose, continue to form new leaflets by a division of the terminal leaflet; deepened as the series continued, until the seven perfect leaflets were formed. The Rhus Toxicodendron, Poison Ivy, is so often spoken of in contradistinction to the ampelopsis quinquefolia, that a study of its leaves was next made. The Rhus Toxicodendron commonly has three more or less entire leaflets, though they are often sinnate or cut-lobed. A number of specimens were found where the lower leaflets had thrown off another pair, making it five-leaved. The tendency, however, seems to be to develop toward nine leaflets rather than five, each of the three leaflets becoming trifoliate. Potentilla Canadensis, the common cinquefoil, next claimed my attention. According to the ideas here, when a new leaflet is about to be formed the terminal leaflet will often

appear to be over-grown, and the outline of the perfect leaf is frequently plainly discernible before the division is complete. (Figs. 25–29.) It is also interesting to observe that often where a new leaflet has been added, a corresponding notch seems to have been cut from the parent leaf. (Figs. 25 and 28.) Then another leaf is thrown off from the opposite side, taking out a similar notch, thus rendering the terminal leaflet again normal and symmetrical. Lambucus Canadensis, the common Elder, shows remarkable respondence to favorable conditions in the increase of its leafage. The plain pinnate leaves are becoming doubly pinnate, and the minute point at the base of the leaflet sometimes also develops into a considerable leaflet. The leaves of Negundo aceroides, Box Elder, furnish numerous examples of this tendency toward a numerical increase of leaflets. It is not at all unusual to find a graduated series, from one to eleven leaflets. The development of the leaflets of the rose, as stated, proved to be an exception to the plan followed by other pinnate leaves, as far as I could find. For a long time search for transition stages was made in vain, when one day while examining the foliage of some tender new shoots, I found the baby leaves in their cradles, as it were. Grant Allen says: "It is the same with plants as with animals; they all pass through a first simple shape, which helps us to picture to ourselves what they once were, so that one of the best ways to discover lost links in the pedigrees of plants, is to watch the development from the seed. The cotyledons, or seed-leaves," he says, "preserve for us still the extremely plain ancestral form, and are the central point from which every variety of foliage first set out." Young shoots may, perhaps, pass through phases of ancestral forms. Those of the rose certainly seem to indicate that such is the case. When a rose leaf is plucked from the stem two stipules will be noticed at the base of the leaf, and strange to say, these stipules seem to be the little mother-leaves, for the leaflets appear to have originated from them. On young shoots the stipules will often be found to be larger than upon the old wood, and if careful examination is made many may be found having a more or less leaf-like form. The upper part of the stipule often assumes the shape and size of the rose leaflet, so that an apparently perfect leaflet is often found still adnate to the stipule; still clinging to it, so to speak, as if loth to be alone in the world. Further development is indicated by the division or separation of the leaflet from the stipule, and as the division continues and new leaflets are thus added, the rachis elongates to make room for the new-comers. (Illustrated by figs. 12–20.) Very many specimens were found, illustrating all stages of division from the stipules. Besides this peculiar manner of increasing the number of leaflets, a few specimens were found in which additional leaflets appear to have been quite irregularly added at the base of the leaflets. No transition stages were found in this case—simply the perfect leaves, as seen in the fourth leaf of four-leaved clover.

Leaves in process of evolution seemed calling for recognition on every side. In the fields and woods, along the road-sides, in the flower-bed and the vegetable garden—everywhere interesting specimens were found. The leaves of the cultivated dahlia and those of the potato, tomato and bean all illustrate this tendency. On very many plants where entire leaves ordinarily obtain, notched or obviously-lobed leaves are often found. Examples of such frequently occur on *symphor icarpus racemosus* (snowberry). Again, on plants bearing slightly lobed leaves many are found quite deeply and conspicuously lobed. An interesting example is furnished by the leaves of the wild grape (shown in figs. 30, 38). *Cimicifuga racemosa*, which has decompound leaves, furnishes a good illustration of both partial and complete division. It is extremely interesting to observe the symmetry which obtains in the various leaf divisions. The mother-leaf, so to speak, usually gives off a new leaf on one side, then appears to husband her energies until she is able to form a correspond-

ing leaf on the opposite side; but it is during this unsymmetrical condition that the investigator finds the key to their manner of division or increase (figs. 25–29). It should be borne in mind, however, that the idea is not meant to be conveyed that this division of leaves takes place during a single season—*i. e.*, it is not meant that the individual leaf or leaflet undergoes this entire evolutionary division during a single season. Various stages of division may be found on one and the same plant at the same time, but only a very slight advance on the previous year is made by succeeding years. Slowly, but surely, heredity transmits this tendency to succeeding generations. So numerous and various are the plants exhibiting this proclivity toward division, that one is led to inquire, *Why* this tendency in leaves to divide?

Grant Allen, in his delightful little book on "Flowers and their Pedigrees," says: "Leaves depend for their growth upon air and sunlight; they must be supplied with carbonic dioxide to assimilate, and solar rays to turn off the oxygen and build up the carbon into their system. In open fields or bare spaces, big leaves like burdock or rhubarb can find food and space, but where carbonic dioxide is scarce, and light is intercepted by neighboring plants, all the leaves must needs be fine and divided into almost thread-like segments. The competition for carbon under such circumstances is exceedingly fierce." For example, he continues, "in water only very small quantities of gas are dissolved, so that all submerged water plants have extremely thin waving filaments instead of flat blades, . . . while hedge-row weeds which jostle thickly against one another have a constant hard struggle for the carbon and sunshine, and grow out accordingly into numerous subdivided leaflets, often split up time after time into segments and sub-segments of the most intricate sort."

Sir John Lubbock, in his little book on "Flowers, Fruits, and Leaves," offers a somewhat different explanation. Taking the position of the leaves, the direction of the bough and various other elements into consideration, he says "it seems clear that there is a correspondence between thickness of stem and size of leaf. This ratio, moreover, when taken in relation with the other conditions of the problem, has a considerable bearing, not only on the size, but also on the form of the leaf." Lubbock also accounts for the minute dissection of submerged aqueous plants on the same principle. "We know," to use his own words again, "that the gills of fish consist of a number of thin plates which, while in water, float apart, but have not sufficient consistence to support even their own weight, much less any external force, and consequently collapse in air. The same thing happens in thin, finely-cut leaves. In still water, they afford the greatest possible extent of surface with the least expenditure of effort in the formation of skeleton. The conditions of still air," Lubbock continues, "would approximate those of water, except so far as they are modified by weight, and the more the plant is exposed to the wind, the more it would require strengthening, hence perhaps the fact," he concludes, "that herbs so much oftener than trees have finely-cut leaves."

Of the two views presented, those of Grant Allen seem the more plausible. Heat and light are certainly the great forces which impel the vegetable world; in order to grow, plants must have air and sunlight, and it seems clear that both air and sunlight will come in contact with a greater leaf-surface when the leaves are much cut up or divided than when they are large. The air and light would pass more freely about, among and over the smaller leaves, and a greater number would receive a portion of these necessities of plant-life.

The element of strength suggested by Lubbock, may also play a part in determining the size and shape of leaves, but it may be viewed from another standpoint perhaps equally plausible. Instead of those plants which are weakest and less exposed being divided because they need less frame-work or skeleton, may it not be a method of adaptation which enables them to withstand wind and storm? Small leaves, or those which are much divided, certainly offer *less* resistance to wind and

storm; for the wind would pass more freely through them, and less injury would be likely to result from breakage or mutilation. This would be more emphatically true in the case of submerged water plants. The finely-dissected foliage would offer less resistance to the passage of water through it; it would sway in unison with the motion of the water, and the injury would certainly be reduced to a minimum, while if the leaves were large it seems obvious that they would be more or less mutilated or injured by the action of the water.

It has been suggested that this tendency towards division might, in part at least, be referable to the agency of insects. The large leaves not only offer more food in compact space, but also afford good standing-ground for the insects while feeding; besides, leaf-rollers could make better use of large leaves than finely-divided ones.

With a view of determining whether this suggestion has any foundation in fact, I prepared a list of the commonest plants in the immediate vicinity of Manhattan that bear large leaves, comprising the following genera:

Æsculus.	Circis.	Plantago.	Scrophularia.
Arctium.	Cucurbita.	Platanus.	Sicyos.
Asimina.	Datura.	Polyginatum.	Smilax.
Cacalia.	Echinocystis.	Populus.	Tilia.
Catalpa.	Eupatorium.	Quercus.	Vitis.
Celastrus.	Menispermum.	Rumex.	Xanthium.
Celtis.	Morus.	Sagittaria.	

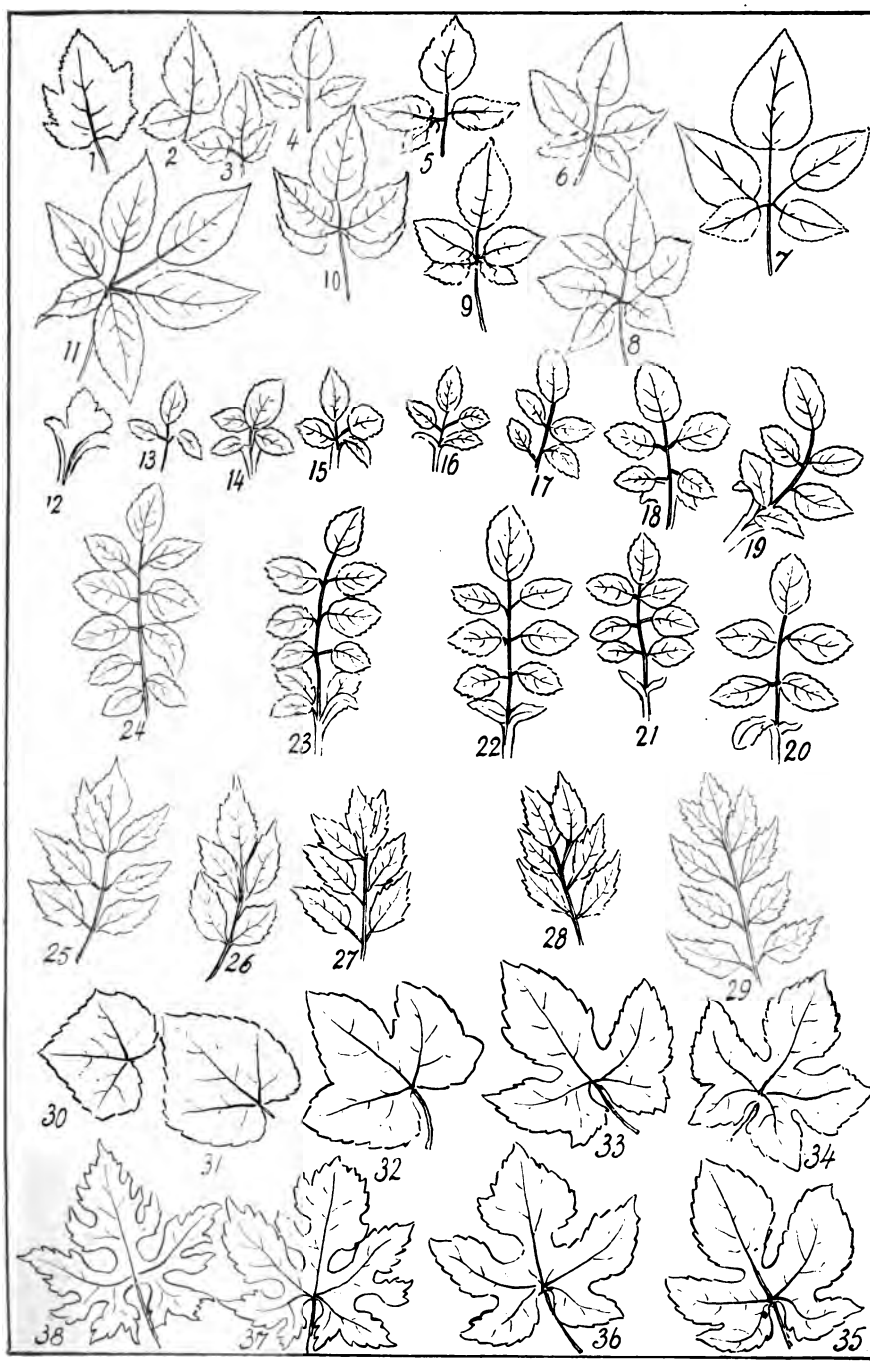
Another list was made of plants in the same region, with very small leaves, or the blades of which were much divided. This second list included the following genera:

Acer.	Cassia.	Houstonia.	Robinia.
Achillea.	Delphinium.	Hymenopappus.	Rosa.
Aquilegia.	Desmanthus.	Leptocaulis.	Salix.
Ambrosia.	Ellisia.	Lygodesmia.	Schrankia.
Amorpha.	Galium.	Lythrum.	Symphoricarpus.
Artemisia.	Geranium.	Melilotus.	Thalictrum.
Astralagus.	Hibiscus.	Pronalea.	

These two lists were handed to an entomologist, with the request that he enumerate the species of insects reported as attacking the several species belonging to the genera. An examination of the enumerated lists revealed the fact, that in case of some of the genera not a single insect while in others as many as twenty insects have been reported as attacking the plants.

The total number of insects on the plants with large leaves was 104. The total number on the plants with small leaves was 152; but, before proceeding further, it may be well to say that the genus *Quercus* was at first included in the list of large leaves, but was subsequently rejected. For this exclusion there seemed to be two, perhaps, sufficient reasons: First, while in some of the oaks the leaves are large and full, in many others they are comparatively small or the blade is cut into medium-sized or small segments. In the second place, only two species of oaks (*Q. primoides* and *Q. macrocarpa*) are very abundant, and three others, (*Q. nigra*, *Q. rubra*, and *Q. tinctoria*,) moderately abundant in the region which furnished the genera of the foregoing lists; and it is evident that of the 117 species of insects reported on the oak, a comparatively few of them should be credited to this district. As stated above, the plants with large leaves harbor *less* instead of more insects than those with the small leaves, as was suggested. That plants with small leaves should harbor a greater number of insects might possibly be explained by reference to the fact that the smaller leaves are usually somewhat more tender, at least have a lighter or less woody framework or skeleton, and therefore, perhaps, furnish more enticing food for insects.

In closing, it may then be remarked that the supposition that the present forms of leaves are both the former and the ultimate ones, is entirely erroneous. Paleontology demonstrates the fact of a long history of a gradual change of forms, and the study detailed above suggests what is going on now. The future forms, therefore, will be the resultant of the environment acting on these variable organs.



EXPLANATION OF PLATE.

Figs. 1-11. Leaves of common blackberry, showing mode of variation from a simple to a 6-foliate leaf.

Figs. 12-24. Leaves of the rose, illustrating developments of leaflets from the stipules.

Figs. 25-29. Leaves of trumpet creeper, illustrating the mode of numerical increase of leaflets by a division of the terminal leaflet.

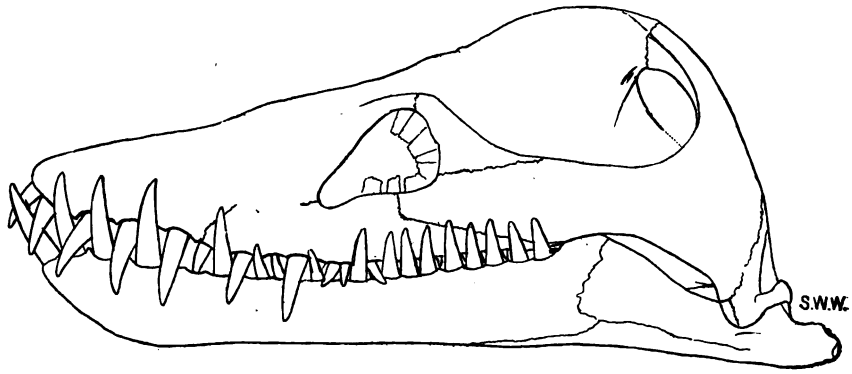
Figs. 30-38. Leaves of wild grape, showing the variation from the entire to the deeply-lobed leaf.

A NEW PLESIOSAUR FROM THE NIOBRARA CRETACEOUS OF KANSAS.

BY S. W. WILLISTON, UNIVERSITY OF KANSAS.

During the past summer, Judge E. P. West, of the University of Kansas, obtained from the chalk of western Kansas a specimen of a plesiosaur, which is of especial interest, both by reason of the comparative rarity of these animals and of the nature and preservation of the remains obtained. The specimen comprises the skull and twenty-eight cervical vertebræ, all attached and with their relative positions but little disturbed. They lie upon the right side, with the usual opisthotonic curve to the neck, and are all laterally compressed. The right side of the skull is not at all disturbed, save from the effects of compression and of chemical action upon the teeth. The upper side, however, though the teeth are in perfect preservation, and the relative positions of the mandible and maxilla are unchanged, has been crowded up about three inches, nearly obliterating the orbit.

In the absence of other material for comparison, and some of the necessary literature, I shall not attempt to enter into a full description of the specimen, but shall reserve such for another time, when my opportunities will be greater. Most of the sutures will, I believe, be traced out, but at present I have not sufficiently distinguished some from the cracks due to compression. In the figure herewith given I have indicated such only as are beyond doubt.



Skull of *Cimoliosaurus* (*Elasmosaurus?*) *Snowii* Will., about ⅓.

SKULL.

Parietals.—The parietals form a high, steep, roof-like covering, ascending into a sharp, thin sagittal crest, extending through nearly their whole length—from near the attachment of the squamosals posteriorly as far forward as the posterior part of the orbit. This crest, throughout most of its extent, forms a plate of bone with nearly parallel sides for about two inches vertically, its thickness on the margin varying from two to four millimeters, and its entire length about 130 millimeters. Posteriorly they expand into a thickened triangular process, directed upward and backward over the supraoccipital—for union with the squamosals. Extending the whole length of the crest is a well-marked suture, and it is possible that at or near the anterior extremity there may have been a parietal foramen; but, if so, the opening has been closed by the compression.

Frontals.—The frontals are small bones; neither the anterior or posterior sutures have been traced, but, allowing for compression, the distance between the upper borders of the orbits could not have exceeded three inches. The two bones meet in a roughened suture, which, for more than an inch, seems to have been imperfectly closed in life.

Post-fronto-orbitals.—These elements appear as a slender bar running downward and backward, and, in life, evidently also obliquely outward. The union with the frontal above and the jugal below is shown in the figure. The bone is triangular in shape, the jugal suture extending back horizontally about 70 mm. I do not find a differentiation of the two elements, though such may have been the case.

Temporal arch.—The jugal enters into the posterior inferior portion of the orbit, articulating more than two inches with the jugal above, and by a long, oblique suture, more than four inches in length, with the maxilla below. Just what its relations posteriorly are I cannot now say. The bone called "squamosal" I at first confined to the upper process, but further cleaning makes the supposed suture a doubtful one.* It is possible that what seems a small ossification at the lower end of the quadrate, in front, may be the quadrato-jugal. If this be so, the bar must consist wholly of the "squamosal" and jugal. The suture distinguishing this "jugal-squamosal" from the quadrate is very distinct, at least in the lower part. It extends from near the lower end, in front, upward and backward, to the posterior surface. Sollas† describes a transverse suture at the anterior part of the arch in *Plesiosaurus Conybeari*, whereby "the jugal, post-orbital and squamosal clearly meet in a T-shaped suture." There is no evidence whatever of any such suture in the present specimen. Did it exist, the squamosal would necessarily articulate with the maxilla, as well as the other bones. Prof. Huxley, as quoted by Sollas (l. cit.), says that, "contrary to what is usually stated, the post-frontal appears to articulate with a bone, the homologue of the squamosal of the crocodile." Possibly he is correct, but I believe not. Certainly there is no such arrangement as he figures and positively states in his Comparative Anatomy; upon what evidence I do not know, as more recent authors (Baur, Lydekker) agree in rejecting his views as improbable. There is but a single temporal arch, and it probably, as Baur suggests, represents both the upper and lower arches of crocodilia, Dinosauria, etc.

Pterygoids.—The pterygoids unite posteriorly with the lower end of the quadrate, and send off a process, evidently the transverse, back of the middle of the mandibles.

Premaxillary. The premaxillaries are large, with pit-like depressions on their outer surface. The median suture is evident; but that separating them from the maxillaries I have traced only a short distance upward and backward.

Sclerotic plates.—Lying within the orbit are thirteen small, thin, bony plates, the largest about 20 mm. in its greatest diameter, with somewhat crenulated edges. The larger part are lying in position; others are misplaced.

Mandible.—The lower jaw, from the tip of the symphysis to the hind extremity, measures just twenty inches, of which the teeth occupy thirteen. Its least width, near the middle, is one and three-fourths inches; its greatest width, just back of the teeth, is nearly three inches. The length of the symphysis is two and three-fourths inches. The two dentaries are firmly coössified, traces of the suture being seen at the posterior part only. The ossification is so complete that compression has not affected the symphysial portion, but, instead, has broken the left ramus just back of the symphysis. The sutures separating the angular, surangular and dentary are, as is seen, very similar in position to those of the crocodile.

Teeth.—There are sockets in the lower jaws for nineteen or twenty teeth. There is possibly one more on the right than on the left side. Those in the upper jaw seem to be the same in number, though the small posterior ones are so covered by the lower teeth that the number cannot be determined positively. The largest teeth of the upper jaw are the five implanted in the premaxillary; back of these

* This process is said to be distinct in some specimens of Plesiosaurs, and is spoken of as the "supra squamosal, or supra temporal." It is probably the *true* squamosal, if distinct. Vide Baur, Jour. of Morph., III, 473.

† Quart. Journ. Geol. Soc., 1881, p. 444.

there is but one large tooth, situated just in front of the orbit. The largest teeth of the lower jaw are the ones corresponding to those of the premaxillary; the posterior teeth, however, are much larger than the corresponding ones in the upper jaw. The anterior teeth, especially, are elongate, conical and lightly recurved. All are sharply pointed, with the crown, to within a half or three-fourths inch of the socket, finely striated. The largest is that of the premaxillary, just in front of the maxillary suture, measuring 53 mm. in length by 13 mm. in width at the base. The first tooth in the lower jaw is fully as long, but a little more slender.

The entire length of the skull is about nineteen inches; its greatest height, about nine inches. The width at the extremity of the quadrates, as indicated by the plane of the mandibular symphysis, could not have been great. It is very evident that the skull was a long and narrow one, quite similar to that of *Plesiosaurus Conybeari* Sollas, and very different from the depressed ones, with flat parietals, indicated by other remains.

Third cervical vertebra. *C. Snowii* Willist. x½.

The extremity of a small bone was found lying upon the inner side of the lower mandible; it is evidently a part of a hyoid bone.

CERVICAL VERTEBRÆ.

Twenty-eight vertebræ, in a continuous series, were obtained by Mr. West, the last five or six, owing to exposure, in less perfect condition; the others with their various processes complete, or nearly so. Traces of the sutures uniting the neural arches with the centra can be distinguished in the third and fourth vertebræ, but in all the others they are entirely obliterated. The atlas and axis have not been separated from the skull, and the characters of the former cannot be made out. There are no zygosxhenes. The third vertebra, as figured, differs from the following ones in the greater obliquity and slightly greater length of the spine, in the more oblique anterior face of the centrum, in the presence of a conspicuous carina below in front, and in the simple, pointed shape of the pleurapophyses. The measurements of this vertebra are as follows:

THIRD CERVICAL VERTEBRA.

Length of centrum, below	23 millim.
Length of centrum, above	20 "
Height of centrum	25 "
Width of centrum	22 "
Height of spine above floor of neural canal	55 "

The fourth vertebra has the neural spine less oblique and broader, the carina, in the middle of the concavity of the under surface, not visible from the side, and the pleurapophysis broad, and of equal width.

FOURTH CERVICAL VERTEBRA.

Length of centrum	30 millim.
Height of centrum	27 "
Height of spine above floor of neutral canal	46 "
Width of spine	24 "
Length of pleurapophyses	43 "
Width of pleurapophyses	24 "

The sixth vertebra has the spine nearly perpendicular, and the pleurapophyses broad, with more marked terminal anterior and posterior prolongations.

SIXTH CERVICAL VERTEBRA.

Length of centrum	48 millim.
Height of centrum	42 "
Height of spine above floor of canal	47 "
Width of spine	36 "

NINTH CERVICAL VERTEBRA.

Length of centrum	53 millim.
Height of centrum	42 "
Height of spine above floor of canal	47 "
Width of spine	40 "
Length of pleurapophyses	40 "
Least width of pleurapophyses	25 "
Greatest width of pleurapophyses, distally	49 "

FOURTEENTH CERVICAL VERTEBRA.

Length of centrum	65 millim.
Height of centrum	50 "
Height of spine	50 "
Width of spine	42 "
Length of pleurapophyses	48 "
Least width of pleurapophyses	32 "
Greatest width of pleurapophyses, distally	56 "

TWENTIETH CERVICAL VERTEBRA.

Length of centrum	78 millim.
Height of centrum	60 "
Height of spine	62 "
Width of spine	65 "
Greatest width of pleurapophyses, distally	65 "

TWENTY-SEVENTH CERVICAL VERTEBRA.

Length of centrum	90 millim.
Height of centrum	68 "

TWENTY-NINTH ? THIRTIETH ? CERVICAL VERTEBRA.

Height of centrum	77 millim.
Width of centrum	74 "
Depth of cup	12 "

SYSTEMATIC POSITION.

In the absence of any definite knowledge of the skull-structure of other American plesiosaurs, and not very much knowledge, and that in a measure contradictory, of the European forms, it is a matter of some difficulty to correctly refer the present species to any definite genus. In Science, vol. XVI, p. 262, I provisionally referred it to *Cimoliosaurus* Leidy, under the name *C. Snowii*, in honor of Chancellor F. H. Snow. But the genus *Cimoliosaurus*, as defined by Lydekker, will include absurdly composite forms. Among the material in the museum of the University of Kansas there are a dozen or more specimens from the Kansas Cretaceous certainly referable to at least three distinct genera, all of which might be included in *Cimoliosaurus* of Lydekker and Zittel.

It cannot be denied that there is a striking resemblance between our present skull and that described by Sollas (loc. cit.) as *Plesiosaurus Conybeari* Sollas, and I am strongly tempted to believe that the two forms are congenerous. On the other hand, such a definition of *Plesiosaurus* as the following, from Zittel's Hand-Buch, vol. III, pp. 489 and 490, will prohibit the admission of our species: " . . . Augenhöhlen rundlich. ungefähr in die Mitte der Schädellänge, ohne verknöcherten Skleroticaring; Schläfenlöcher gross, vierseitig. . . . Scheitelbeine verschmolzen, schmal und kurz; Jochbein kräftig, gebogen; Quadratjochbein nach hinten vorspringend, die seitliche Hinterecke des Schädels bildend. . . . Zahnbeine vorn zu einer breiten

Symphyse verschmolzen. . . . Sämmtliche Wirbelkörper sind ziemlich kurz, vorn und hinten fast flach oder nur ganz schwach ausgehöhlt; die Bogen durch Nähte mit dem Centrum verbunden, so das sie sich leicht ablöen." Furthermore, both Seeley and Lydekker would restrict the genus *Plesiosaurus* to the Lias.

From *Cimoliosaurus*, in Lydekker's wide sense, there are important differences. The anterior teeth are much larger than the posterior ones, and there are no xygosphenes on the cervical vertebræ. But, while the genus is evidently different from *Cimoliosaurus* as there defined, it is not so certain that it is distinct from some of the forms included under it. Lydekker, and, following him, Zittel, divide *Cimoliosaurus* into two groups, the cœlospondyline, "probably equivalent to *Polycotylus* Cope," and the "Typical Group," including *Elasmosaurus* Cope, *Mauisaurus* Hector, and *Murœnosaurus* Seely. From this group, Lydekker's definition will sharply exclude our form; but, nevertheless, I do not feel so sure that it is generically different from *Elasmosaurus*. Cope had only a fragment of the skull, and the cervical vertebræ that he describes and figures had the processes so broken away that there is but little left for comparison, save the relative lengths. From this character alone it appears that the vertebræ of our species are less slender, the greatest disproportion between length and height being as nine to seven, while a median cervical of *Elasmosaurus platyurus* Cope, figured by the author, has a relation of eight to five. There are, also, other differences in the sculpturing, which are, at least, of specific value. If the type of *Elasmosaurus* has zygosphenal vertebræ, there can be no question of the generic distinction; but I cannot find any statement of the author to that effect. So the question must yet remain of the generic identity of the animal until more material has been obtained. Of the specific distinction, however, there can be scarcely a question, and, hence, the name here given.

Great credit is due to Mr. West for his recognition of the value of this specimen, and his corresponding care in its collection. I desire, also, to express my thanks to my friend, Dr. George Baur, of Clark University, for the communication of literature, and various suggestions.

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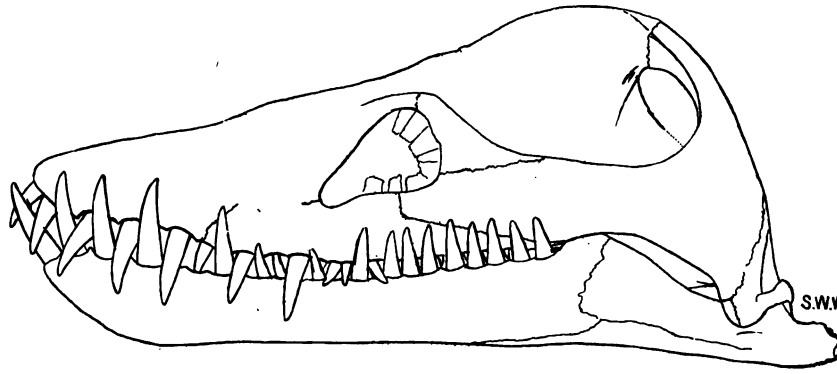
A NEW PLESIOSAUR FROM THE NIOBRARA CRETACEOUS OF KANSAS.

BY S. W. WILLISTON, UNIVERSITY OF KANSAS.

During the past summer, Judge E. P. West, of the University of Kansas, obtained from the chalk of western Kansas a specimen of a plesiosaur, which is of especial interest, both by reason of the comparative rarity of these animals and of the nature and preservation of the remains obtained. The specimen comprises the skull and twenty-eight cervical vertebræ, all attached and with their relative positions but little disturbed. They lie upon the right side, with the usual opisthotonic curve to the neck, and are all laterally compressed. The right side of the skull is not at all disturbed, save from the effects of compression and of chemical action upon the teeth. The upper side, however, though the teeth are in perfect preservation, and the relative positions of the mandible and maxilla are unchanged, has been crowded up about three inches, nearly obliterating the orbit.

In the absence of other material for comparison, and some of the necessary literature, I shall not attempt to enter into a full description of the specimen, but shall reserve such for another time, when my opportunities will be greater. Most of the sutures will, I believe, be traced out, but at present I have not sufficiently distinguished some from the cracks due to compression. In the figure herewith given I have indicated such only as are beyond doubt.



Skull of *Cimoliosaurus* (*Elasmosaurus?*) *Snowii* Will., about $\frac{1}{5}$.

SKULL.

Parietals.—The parietals form a high, steep, roof-like covering, ascending into a sharp, thin sagittal crest, extending through nearly their whole length—from near the attachment of the squamosals posteriorly as far forward as the posterior part of the orbit. This crest, throughout most of its extent, forms a plate of bone with nearly parallel sides for about two inches vertically, its thickness on the margin varying from two to four millimeters, and its entire length about 130 millimeters. Posteriorly they expand into a thickened triangular process, directed upward and backward over the supraoccipital—for union with the squamosals. Extending the whole length of the crest is a well-marked suture, and it is possible that at or near the anterior extremity there may have been a parietal foramen; but, if so, the opening has been closed by the compression.

Frontals.—The frontals are small bones; neither the anterior or posterior sutures have been traced, but, allowing for compression, the distance between the upper borders of the orbits could not have exceeded three inches. The two bones meet in a roughened suture, which, for more than an inch, seems to have been imperfectly closed in life.

Post-fronto-orbitals.—These elements appear as a slender bar running downward and backward, and, in life, evidently also obliquely outward. The union with the frontal above and the jugal below is shown in the figure. The bone is triangular in shape, the jugal suture extending back horizontally about 70 mm. I do not find a differentiation of the two elements, though such may have been the case.

Temporal arch.—The jugal enters into the posterior inferior portion of the orbit, articulating more than two inches with the jugal above, and by a long, oblique suture, more than four inches in length, with the maxilla below. Just what its relations posteriorly are I cannot now say. The bone called "squamosal" I at first confined to the upper process, but further cleaning makes the supposed suture a doubtful one.* It is possible that what seems a small ossification at the lower end of the quadrate, in front, may be the quadrato-jugal. If this be so, the bar must consist wholly of the "squamosal" and jugal. The suture distinguishing this "jugal-squamosal" from the quadrate is very distinct, at least in the lower part. It extends from near the lower end, in front, upward and backward, to the posterior surface. Sollas† describes a transverse suture at the anterior part of the arch in *Plesiosaurus Conybeari*, whereby "the jugal, post-orbital and squamosal clearly meet in a T-shaped suture." There is no evidence whatever of any such suture in the present specimen. Did it exist, the squamosal would necessarily articulate with the maxilla, as well as the other bones. Prof. Huxley, as quoted by Sollas (l. cit.), says that, "contrary to what is usually stated, the post-frontal appears to articulate with a bone, the homologue of the squamosal of the crocodile." Possibly he is correct, but I believe not. Certainly there is no such arrangement as he figures and positively states in his Comparative Anatomy; upon what evidence I do not know, as more recent authors (Baur, Lydekker) agree in rejecting his views as improbable. There is but a single temporal arch, and it probably, as Baur suggests, represents both the upper and lower arches of crocodilia, Dinosauria, etc.

Pterygoids.—The pterygoids unite posteriorly with the lower end of the quadrate, and send off a process, evidently the transverse, back of the middle of the mandibles.

Premaxillary.—The premaxillaries are large, with pit-like depressions on their outer surface. The median suture is evident; but that separating them from the maxillaries I have traced only a short distance upward and backward.

Sclerotic plates.—Lying within the orbit are thirteen small, thin, bony plates, the largest about 20 mm. in its greatest diameter, with somewhat crenulated edges. The larger part are lying in position; others are misplaced.

Mandible.—The lower jaw, from the tip of the symphysis to the hind extremity, measures just twenty inches, of which the teeth occupy thirteen. Its least width, near the middle, is one and three-fourths inches; its greatest width, just back of the teeth, is nearly three inches. The length of the symphysis is two and three-fourths inches. The two dentaries are firmly coössified, traces of the suture being seen at the posterior part only. The ossification is so complete that compression has not affected the symphysial portion, but, instead, has broken the left ramus just back of the symphysis. The sutures separating the angular, surangular and dentary are, as is seen, very similar in position to those of the crocodile.

Teeth.—There are sockets in the lower jaws for nineteen or twenty teeth. There is possibly one more on the right than on the left side. Those in the upper jaw seem to be the same in number, though the small posterior ones are so covered by the lower teeth that the number cannot be determined positively. The largest teeth of the upper jaw are the five implanted in the premaxillary; back of these

*This process is said to be distinct in some specimens of Plesiosaurs, and is spoken of as the "supra squamosal, or supra temporal." It is probably the *true* squamosal, if distinct. Vide Baur, Jour. of Morph., III, 473.

†Quart. Journ. Geol. Soc., 1881, p. 444.

there is but one large tooth, situated just in front of the orbit. The largest teeth of the lower jaw are the ones corresponding to those of the premaxillary; the posterior teeth, however, are much larger than the corresponding ones in the upper jaw. The anterior teeth, especially, are elongate, conical and lightly recurved. All are sharply pointed, with the crown, to within a half or three-fourths inch of the socket, finely striated. The largest is that of the premaxillary, just in front of the maxillary suture, measuring 53 mm. in length by 13 mm. in width at the base. The first tooth in the lower jaw is fully as long, but a little more slender.

The entire length of the skull is about nineteen inches; its greatest height, about nine inches. The width at the extremity of the quadrates, as indicated by the plane of the mandibular symphysis, could not have been great. It is very evident that the skull was a long and narrow one, quite similar to that of *Plesiosaurus Conybeari* Sollas, and very different from the depressed ones, with flat parietals, indicated by other remains.

Third cervical vertebra. *C. Snowii* Willist. xi.

The extremity of a small bone was found lying upon the inner side of the lower mandible; it is evidently a part of a hyoid bone.

CERVICAL VERTEBRÆ.

Twenty-eight vertebræ, in a continuous series, were obtained by Mr. West, the last five or six, owing to exposure, in less perfect condition; the others with their various processes complete, or nearly so. Traces of the sutures uniting the neural arches with the centra can be distinguished in the third and fourth vertebræ, but in all the others they are entirely obliterated. The atlas and axis have not been separated from the skull, and the characters of the former cannot be made out. There are no zygosxhenes. The third vertebra, as figured, differs from the following ones in the greater obliquity and slightly greater length of the spine, in the more oblique anterior face of the centrum, in the presence of a conspicuous carina below in front, and in the simple, pointed shape of the pleurapophyses. The measurements of this vertebra are as follows:

THIRD CERVICAL VERTEBRA.

Length of centrum, below	23 millim.
Length of centrum, above	20 "
Height of centrum	25 "
Width of centrum	22 "
Height of spine above floor of neural canal	55 "

The fourth vertebra has the neural spine less oblique and broader, the carina, in the middle of the concavity of the under surface, not visible from the side, and the pleurapophysis broad, and of equal width.

FOURTH CERVICAL VERTEBRA.

Length of centrum	30 millim.
Height of centrum	27 "
Height of spine above floor of neutral canal	46 "
Width of spine	24 "
Length of pleurapophyses	43 "
Width of pleurapophyses	24 "

The sixth vertebra has the spine nearly perpendicular, and the pleurapophyses broad, with more marked terminal anterior and posterior prolongations.

SIXTH CERVICAL VERTEBRA.

Length of centrum	48 millim.
Height of centrum	42 "
Height of spine above floor of canal	47 "
Width of spine	36 "

NINTH CERVICAL VERTEBRA.

Length of centrum	53 millim.
Height of centrum	42 "
Height of spine above floor of canal	47 "
Width of spine	40 "
Length of pleurapophyses	40 "
Least width of pleurapophyses	25 "
Greatest width of pleurapophyses, distally	49 "

FOURTEENTH CERVICAL VERTEBRA.

Length of centrum	65 millim.
Height of centrum	50 "
Height of spine	50 "
Width of spine	42 "
Length of pleurapophyses	48 "
Least width of pleurapophyses	32 "
Greatest width of pleurapophyses, distally	56 "

TWENTIETH CERVICAL VERTEBRA.

Length of centrum	78 millim.
Height of centrum	60 "
Height of spine	62 "
Width of spine	65 "
Greatest width of pleurapophyses, distally	65 "

TWENTY-SEVENTH CERVICAL VERTEBRA.

Length of centrum	90 millim.
Height of centrum	68 "

TWENTY-NINTH ? THIRTIETH ? CERVICAL VERTEBRA.

Height of centrum	77 millim.
Width of centrum	74 "
Depth of cup	12 "

SYSTEMATIC POSITION.

In the absence of any definite knowledge of the skull-structure of other American plesiosaurs, and not very much knowledge, and that in a measure contradictory, of the European forms, it is a matter of some difficulty to correctly refer the present species to any definite genus. In Science, vol. XVI, p. 262, I provisionally referred it to *Cimoliosaurus* Leidy, under the name *C. Snowii*, in honor of Chancellor F. H. Snow. But the genus *Cimoliosaurus*, as defined by Lydekker, will include absurdly composite forms. Among the material in the museum of the University of Kansas there are a dozen or more specimens from the Kansas Cretaceous certainly referable to at least three distinct genera, all of which might be included in *Cimoliosaurus* of Lydekker and Zittel.

It cannot be denied that there is a striking resemblance between our present skull and that described by Sollas (loc. cit.) as *Plesiosaurus Conybeari* Sollas, and I am strongly tempted to believe that the two forms are congenerous. On the other hand, such a definition of *Plesiosaurus* as the following, from Zittel's Hand-Buch, vol. III, pp. 489 and 490, will prohibit the admission of our species: " . . . Augenhöhlen rundlich. ungefähr in die Mitte der Schädellänge, ohne verknöcherten Sklerotikaring; Schläfenlöcher gross, vierseitig. . . . Scheitelbeine verschmolzen, schmal und kurz; Jochbein kräftig, gebogen; Quadratjochbein nach hinten vorspringend, die seitliche Hinterecke des Schädels bildend. . . . Zahnbeine vorn zu einer breiten

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